CONSTRUCTION TRENDS

Notes on significant movements in the construction industry

Changes in the Construction Pattern

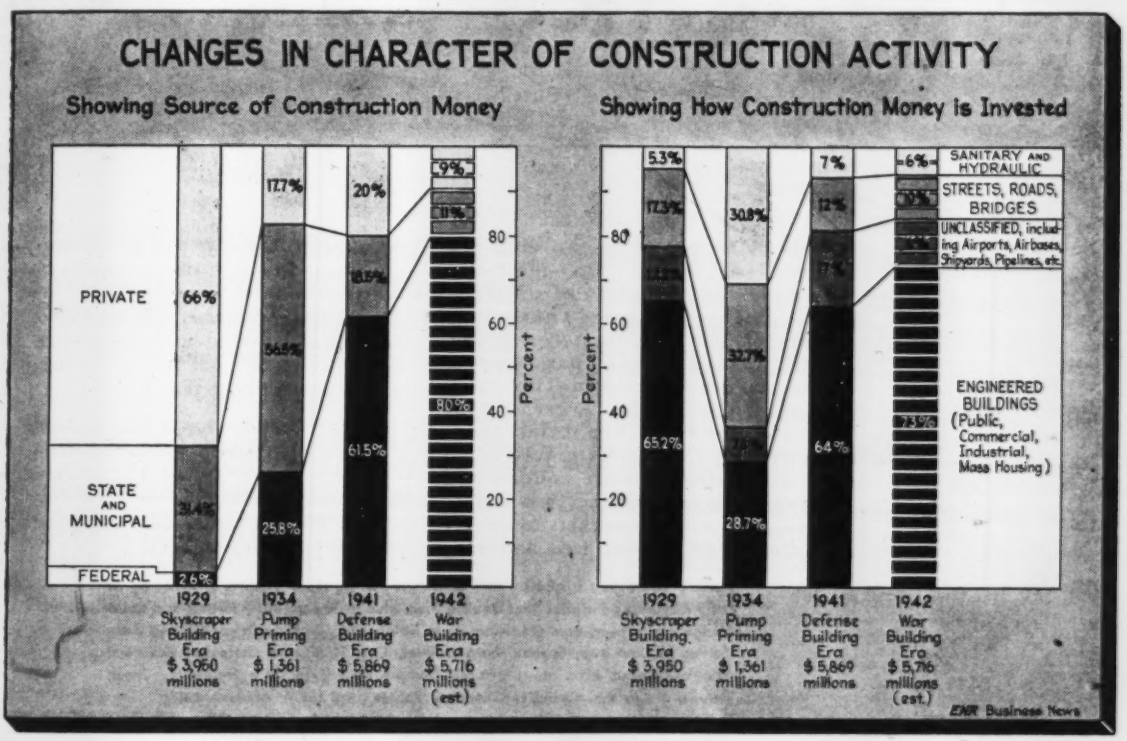
SPEEDING INTO a war economy with a wide-open throttle, the construction industry is headed for one of its biggest years. Estimates for 1942 indicate that engineering construction will closely approximate that reported for the year 1941, $5,869,000,000.

Approximately four-fifths of the anticipated volume will be of federal origin in view of the concentration on strategic war construction; 11 percent is expected to be state and municipally-owned; and 9 percent, private. In 1941, the defense building era, 61.5 percent of the total was federal; 18.5 percent, state and municipal; and 20 percent private.

Compare these huge federal construction ratios with 1929, the peak year in the skyscraper-building era. At that time only 2.6 percent of the construction total was federally financed; 31.4 percent was state and municipal; but almost two-thirds, 66 percent, was private work. In 1934, the pump-priming era, federal work made up 25.8 percent of the total, but the bulk of construction, 56.5 percent was state and municipal. Private volume slumped to 17.7 percent of the $1,361,000,000 reported.

Almost three-quarters of the volume estimated for 1942 is expected to be spent for engineered buildings, with particular stress being placed on structures of a military nature, which, of course, are to be federally financed. Engineered buildings also dominated the picture in 1941, with 64 percent of the total going into this type of construction.

Buildings played a major role in 1929 construction, accounting for 65 percent of the $3,950,000,000 reported. Most of these structures, however, were of the commercial and industrial type, and were privately financed, whereas today's major portion is federal.



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THIS WEEK

• As the movement of military equipment and increasing commercial traffic begins to impose more and more demands upon all highway bridges, the novel method of strengthening existing steel structures (described in this issue) by integrating a concrete roadway slab with the steel floor system, is of unusual significance at this time. See page 61.

• Ships built today are wider than those used 25 years ago. Therefore, when old shipways were converted recently, greater clearance had to be provided for the overhead crane runways. To obtain the necessary clearance without building new foundations, unbraced cylindrical steel columns were employed. This innovation in design is described on page 46.

• After a series of exhaustive test and analytical studies, The Asphalt Institute has developed a standard specification for an asphalt enamel that can be relied upon to satisfactorily fulfill all requirements for use in protecting steel pipe against deterioration. A resume of the Institute's findings and the resultant specification are given on page 49.

THINGS TO COME

• To meet the increasing demands for aluminum resulting from the speed-up of aircraft production schedules, the Aluminum Co. of America has completed two unusually interesting dams on the Little Tennessee River to supplement it's power system. Glenville Dam, with the highest head east of the Rocky Mountains is described in this issue, and will be followed by an article on Nanthala, highest earth-and-rock fill dam in eastern U. S., in the Mar. 12 issue.

• Aerial photography, a subject of vital interest in peace time, as well as in war, becomes of more concern with the development of a method whereby a third dimension can be added so that the pictures show terrain in relief without the aid of a stereoscope. In Mar. 12 issue.

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ENGINEERING NEWS-RECORD • FEBRUARY 26, 1942 • VOLUME 128 • NUMBER 9

Shakeup in Federal Housing Consolidates Many Agencies

Creation of National Housing Agency brings together under one head all house-building and house-financing activities. J. B. Blandford, Jr., appointed administrator

All the house-building and house-financing agencies of the federal government were consolidated by the President this week into a new independent agency, the National Housing Agency. NHA, which is entirely independent of the Federal Works Agency, will handle construction of war housing, now scattered among some nine agencies, will have the slum-clearance functions of the United States Housing Authority, the mortgage-insurance job of the Federal Housing Authority, and the lending activities of a group of RFC subsidiaries—the Federal Home Loan Bank Board, the Home Owners Loan Corporation and the Federal Savings and Loan Insurance Corporation.

Heading NHA is John B. Blandford, Jr. Blandford was coordinator and later general manager of TVA from 1933 to 1939. Since that time he has been assistant director of the Bureau of the Budget. Educated as a mechanical engineer, Blandford early specialized in municipal administration and has held administrative jobs in Cincinnati, Newark and Petersburg, Va.

The National Housing Agency will have three divisions. The FHA is transferred unchanged from the now-abolished Federal Loan Agency to form one division of NHA. The various lending groups become a second division, the Federal Home Loan Bank Administration. To a third division, the Federal Public Housing Authority, is transferred the entire job of building housing—war or slum clearance—with public funds. FPHA is built around the former U. S. Housing Authority, and Leon Keyserling, who has been acting administrator of USHA, is designated acting administrator of the new FPHA. The new agency will build all war housing except that actually located on army or navy reservations, which will be handled by the services.

Transfer of projects now underway to the new organization will be gradual. Each existing agency will carry on as at present until directed by NHA to make the transfer. Moreover, as previously pointed out in *Engineering News-Record* (Feb. 19, p. 299), the system that FWA has been developing for the handling of war housing projects—keeping them closely tied to the administrator—will facilitate transfer to the new centralized setup. Personnel of the former housing agencies is automatically transferred, though it is expected that a considerable number of people will be found unnecessary in the centralized setup.

First casualty of the reorganization is the housing coordinator, Charles F. Palmer, whose job of deciding where war housing is necesary has been transferred to Blandford. Ex-coordinator Palmer is being sent to England to study housing experience there for NHA.

The reorganization has stimulated some speculation as to the future of the gutted Federal Works Agency. With its biggest job removed, FWA is left with the comparatively small-scale defense public works program. It also has the steadily shrinking WPA, the Public Buildings Administration (now limited almost entirely to construction of temporary buildings in Washington) and the practically autonomous Public Roads Administration. Some people are guessing that General Fleming, FWA administrator, will be shifted to a bigger job.

• • •

Tractor sales restricted to A-1 priority orders

The War Production Board last week forbid the sales of any new track-type tractor except on an order with an A-1 priority rating. The order, which forbids sales by manufacturers, distributors, and dealers, also forbids sale of such accessories as bulldozers, angledozers, power control units, and winches. Although sales are limited by the order, known as L-53, to A-1 rated orders, contractors who feel that the order imposes special hardships upon them may appeal for exemption to the Farm Equipment Branch of the War Production Board.

The present order is, essentially, an interim arrangement designed to freeze the existing situation until WPB can make up its mind what to do about a developing shortage of tractors. Estimates of demand for track-laying tractors in 1942 run well over 50,000 units. And it is not believed that production in 1942 will exceed 30–35,000 tractors. Direct military and lend-lease requirements could easily absorb this full output.

Production of tractors in 1941 amounted to 29,849 units, according to WPB.

Restriction of deliveries to A-1 rated orders does not automatically provide contractors on high-rated munitions plants and cantonments with new tractors. The P-19 project rating used on such jobs can be extended only for the purchase of goods to be physically incorporated in the project, not for equipment. In order to get a tractor, a contractor even on a high-rated job will have to obtain from the Army or Navy contracting officer in charge of the job a rating on form PD-3A for the specific tractor order.

• • •

Enlargement of Ross Dam recommended to WPB

An increase in the height of Seattle's Ross Dam on the Skagit River was recommended to the War Production Board last week by the Bonneville advisory board. An increase of 182 ft. in height, at a cost of seven to eleven million dollars would firm up 79,000-kw. of power within two years without installation of any additional generators.

The Ross Dam proposal was part of a 1,193,000-kw. power program proposed by the advisory board to meet war needs. The board is a Congressionally authorized body made up of representatives of the Bonneville Administration, the Federal Power Commission, the Corps of Engineers, the Department of Agriculture, and the Department of the Interior. Its recommendations, however, have no binding effect.

Army develops new type of camp shelters

Prefabricated buildings of sturdy construction which can be easily shipped, quickly assembled and are of types suitable for housing troops in varying climates have been developed by the Corps of Engineers.

Several thousand of the ready-made buildings already have been purchased by the War Department for quartering troops where permanent construction is not necessary or feasible. Erection of prefabricated units will not replace methods of constructing large cantonments of a permanent character. The prefabricated buildings are approximately 20 ft. wide, from 48 to 100 ft. long, and accommodate 20 to 40 men each. They are of all-wood or wood and steel construction.

One of the all-wood types is designed for erection in temperate climates such as the United States, another for use in tropical climates and a third for erection in cold climates. Types designed for erection in the tropics have insulated roofs and stand well above the ground to protect troops against reptiles and insects. Those for cold climates are well insulated and strong enough to resist a heavy gale. A fourth type, made of steel with a wooden floor and with ample inside insulation, also will be used in frigid climates.

One each of the four types has been erected at Fort Belvoir, Va., for additional experimental purposes. Experiments have disclosed that one of the buildings can be erected by 12 workers in less than half a day.

• • •

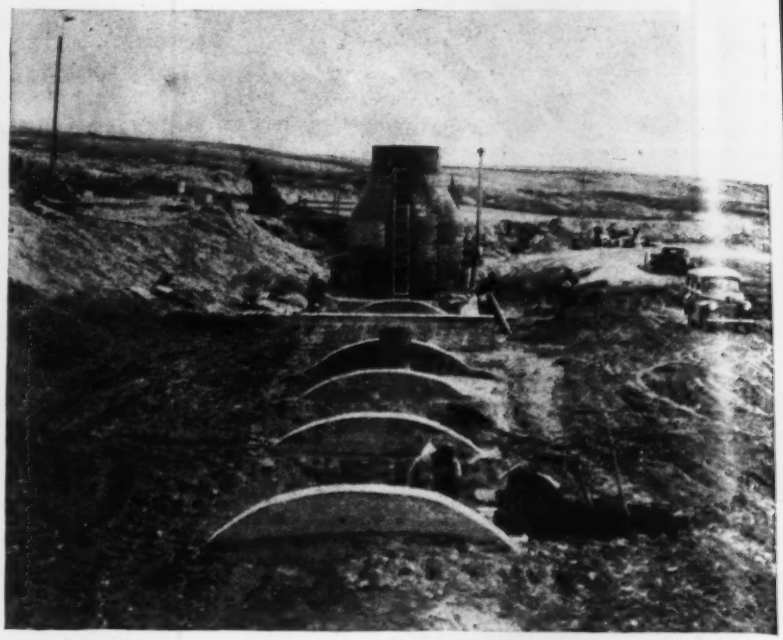
Chicago subway may be used as air raid shelter

Engineers have estimated that the new $8\frac{3}{4}$-mile subway system in Chicago could be used by 130,000 persons as an air-raid shelter, as no trains will be running before June of 1942.

Without bunks, for sleepers, the air-raid capacity of the subway would be more than double, and probably the entire daytime population of the Loop district, could be housed for brief periods by utilization of the subway, and subbasements of underground buildings.

There is 18 to 20 ft. of clay between the top of the subway tunnel and the surface, and the tubes are encased with a $\frac{3}{8}$ in. steel lining and 2 ft. of reinforced concrete.

The $64,000,000 project was started three years ago, and the initial two-route system is now 90 percent complete. Equipping of the State street subway, to be placed in operation first, is 81 percent complete. Yet to be started is the Congress St. leg, a turn-around loop at the south end of the Dearborn St. subway.



Outlet conduit for Box Butte Dam in Nebraska

Backfilling operations along the outlet conduit through Box Butte Dam of he Mirage Flats irrigation project in Nebraska is being carried forward during cold weather to facilitate construction operations in the dam when they are resumed actively in the spring. This view is looking downstream along the top of the conduit toward the gate chamber, forms for which have been set. Cutoff collars are spaced at 20-ft. intervals along the conduit to check seepage.

Box Butte Dam is to be a rock-blasted earth-fill 66 ft. high and 54,000 ft. long across the Niobrara River valley northwest of Alliance, Neb. About 30,000 acre-ft. of water are to be stored in the reservoir formed by the dam, the water to be used to irrigate 12,000 acres of land.

The conduit here shown is of reinforced concrete 54 in. in diameter. It will have a capacity of 300 cfs., flow being controlled by four hydraulically-controlled slide gates in the gate chamber. There also is to be a side-channel spillway 150 ft. long through the left abutment of the dam which will have a capacity of 6,000 cfs. at a 5-ft. depth over the spillway crest.

Work on the dam began in January, 1941. It is being built with WPA and CCC labor for the U. S. Bureau of Reclamation.

The dam will cost $815,000 and the entire project $2,560,000.

Water source selected for Wilmington, N. C.

Wilmington, N. C., will develop a new water supply on the Cape Fear River above the dam and lock at Kings Bluff, basing the development on recommendations made by Malcolm Pirnie, New York consulting engineer.

The city council has instructed W. C. Olsen, consulting engineer of Raleigh, to prepare plans for the new supply works, a filtration plant and general improvement to the distribution system. The Pirnie report stated that the Kings Bluff site would be the best supply source, if the city is to escape heavy infiltration of sea water, a periodic occurrence with the present supply (*ENR*, Nov. 13, 1941, p. 16). Present supplies are drawn from Toomer's Creek.

Faced with a great rise in population due to shipyard and army camp activities nearby, the city has already called for bids on the construction of two water storage tanks and additions to the present system of water mains. Meanwhile, city manager James G. Wallace has suggested sinking ten wells at strategic locations in order that salt-free water might be obtained when needed until the new supply system is completed.

• • •

Panama locks to Rosoff

A contract for the Gatun locks on the Panama Canal was awarded on Feb. 24 to the Rosoff Panama Construction Co., Inc., of New York City, which submitted the low bid of $45,705,000 (*ENR*, Jan. 15, p. 74). The work involves construction of the lock and chambers along with the installation of gates and operating machinery, but does not include excavation. The lock and chamber installation is $1\frac{1}{2}$ miles in length.

Funds for war construction reach a total of eighteen and a half billion

Estimate by war production board includes authorizations during period of April 1940 through February 1942, and covers construction of all facilities

An estimated total of more than eighteen and a half billion dollars has been authorized for expenditure on war construction alone in the period April 18, 1940 through February 7, 1942, according to a tabulation released this week by the Division of Statistics, War Production Board.

The authorizations are a part of the total of $145,400,000,000 estimated by the Division as authorized by Congress, the Reconstruction Finance Corporation, foreign governments and other agencies.

The total funds authorized include $104,698,000,000 made available by Congress; $5,130,000,000 in commitments of the RFC, foreign orders of $4,066,000,000, and pending legislation which will authorize an estimated net of $31,500,000,000.

A breakdown of the figures as released shows authorizations of $18,692,000,000 for construction, including industrial facilities, posts, depots, and stations, and emergency housing; $78,553,000,000 for munitions and $12,583,000,000 for miscellaneous items, which include pay, subsistence and travel of the armed forces, stockpile, lend-lease, agricultural exports, civilian defense, and the like.

Commentary on the increasing urgency of construction is afforded by a tabulation of expenditures as authorized in the period of the war effort, which shows that from a first appropriation of $5,300,000 included in the Independent Offices Appropriation Act for 1941, dated April 18, 1940, the authorizations rose to a high of $2,343,000,000 in the Naval Appropriations Act of February 7, 1942.

How money was appropriated

Appropriations in the increasing war effort were marked by highlights which included $385,000,000 in the military appropriation act for 1941, dated June 13, 1940; $504,800,000 included in the first supplemental national defense appropriation act for 1941, dated June 26, 1940; $270,000,000 included in the third supplemental national defense appropriation act, for 1941, dated Oct. 8, 1940; $1,551,000,000 included in the fourth national defense appropriation act for 1941, dated March 17, 1941; $752,000,000 included in the defense aid supplemental appropriation act for 1941, dated March 27, 1941; $1,201,100,000 included in the fifth supplemental national defense appropriation act for 1941, dated April 5, 1941; $1,022,000,000 included in the military appropriation act for 1942, dated June 30, 1941; $2,287,000,000 included in the third supplemental national defense appropriation act for 1942, dated December 17, 1941; and $963,000,000 included in the fourth supplemental national defense appropriation act for 1942, dated January 30, 1942.

Wrought iron pipe is re-used after 60 years

More than a mile of wrought-iron pipe, said to have supplied San Francisco with its only water supply immediately following the earthquake and fire of 1906, has been dug up and re-laid in a new location after a service life estimated at more than 60 years.

The city water department reported that it removed and re-laid in another location approximately 1,340 feet of 22-in. dia. pipe with 1/8 in. thick walls, and 5,430 ft. of 23-in. dia. pipe with 3/16-in. thick walls, to make way for a Metropolitan Life building program on the Inglewood golf course in West San Francisco.

Chemical analysis of the 22-in. dia. section showed the following characteristics; Carbon, 0.021 percent; manganese, 0.033; phosphorus, 0.265; sulphur, 0.027; silicon, 0.192; slag, 3.31. According to the Electrical and Mechanical Co. of San Francisco, who examined the pipe while the line was being relocated, the pipe is all in excellent condition.

Am.Soc.C.E.spring meeting to be held at Roanoke

The spring meeting of the American Society of Civil Engineers is to be held at the Hotel Roanoke, Roanoke, Va., April 22–23, instead of at New Orleans as announced tentatively last year. The board of direction will meet on Monday, April 20; there will be a conference of representatives of the local sections of the southeastern area on Tuesday, and the general meeting will begin on Wednesday morning with a session devoted to civilian protection in wartime. Technical division meetings will be held Wednesday afternoon and Thursday.

• • •

Civil defense studied by many engineers

Over 250 engineers, public-works officials and professors from engineering colleges met in New York Feb. 16-21 for a conference on aerial bombardment protection sponsored by the College of Engineering at New York University in cooperation with the Office of Civilian Defense and the U. S. Office of Education. Representatives came from all parts of the country, including several from the Pacific Coast. Many were official representatives of city public works departments, of college engineering departments or of local sections of the American Society of Civil Engineers.

Sessions of the conference were held during the morning, afternoon and evening of each day during the week, generally in the Engineering Societies Building. Additional sessions for college professors were held Feb. 22-24. The Metropolitan Section, American Society of Civil Engineers, was host to the out-of-town delegates at an informal reception at the Engineers Club, Feb. 20.

The conference had a dual objective, first to provide as many cities as possible with a small group of engineers with up-to-date knowledge of how best to cope with bombing, and second, to provide the nuclei for local training courses in protection against bombing.

• • •

Corps of Engineers offices moved to Atlanta

The office of the South Atlantic Division, Corps of Engineers, in Richmond, Va. has been closed and moved to 50 Whitehall St., Atlanta, Ga. Col. J. S. Bragdon, division engineer, announced that the Atlanta telephone number is Jackson 6180 and the Atlanta teletype number is AT 565 U. Mail address is: Division Engineer, South Atlantic Division, P. O. Box 4114, Atlanta, Ga.

Associated General Contractors pledge cooperation in first war-time meeting

Resolve to aid government fully in emergency, discuss labor stabilization, post war planning at 23rd annual convention

Grimly determined that the contracting element of the construction industry will carry out its war-building assignment even better and faster than the defense-building program of the past 18 months, the Associated General Contractors of America met at Indianapolis last week in their first war-time convention. Suddenly switched from Seattle to the Midwest only a few weeks ago because of war conditions on the West Coast, the convention was not a pleasant one as AGC meetings usually go.

The AGC was born amid the post-war chaos in construction 23 years ago. The value of such an organization in the present emergency was highly apparent at the Indianapolis meeting, where high-ranking army, navy and federal officials expressed their appreciation for the work of the association in discussing war and postwar construction problems. The AGC again pledged its full service to the war effort, and urged the better and wider use of the small contractors of the country.

General Reybold speaks

Maj. Gen. Eugene Reybold, chief of engineers, U. S. Army, was one of the principal speakers. He summed up the reasons for participation in the war as a fight to preserve our country as we know it, a preservation of "the old American order." He explained the latter as follows: "I could do no better than cite you this very meeting here in Indianapolis. What a significant thing it is that we are able to hold a meeting like this. In Germany such a meeting would be unthinkable. In Germany a contractor, even if he retains the title of contractor, is nothing more than a chattel of the state.

He pointed out the relations between the Corps of Engineers and the contractors for the past 100 years in building innumerable public works as having created an engineer-contractor team that ranks with the combat forces in importance in this emergency.

Under the circumstances, the cost-plus-fixed-fee contract as used largely up to now on Army construction work in the defense program was necessary and called for no apology, the General said, and he pointed out that this type of contract is out for all but exceptional cases. "That era is over because we now have sufficient knowledge to estimate accurately what a project should cost, and because, we have energetically gone after the matter of future planning. We are able, in a large measure, to return to our old standby, lump sum or unit price contracts. It has been a pleasant reunion."

"We now have another form of contract brought about by still other conditions. I refer to the so-called architect-engineer-manager, or as it is called, the A.E.M. form of contract.

Later in the convention the type of war construction contract, particularly the new A.E.M. type, came in for much discussion. The contractors felt that it is highly desirable that a contracting firm be associated with the architect-engineer and the management of projects to be built under this type of contract. Without competent overall direction of construction operations the construction speed of a project under this type of contract might suffer. Therefore the convention urged in a resolution that those charged with responsibility of awarding government contracts be guided solely by speed of construction.

Commander Vernon R. Dunlap, representing Rear Admiral Ben Moreell, chief, Bureau of Yards and Docks, U. S. Navy, discussed briefly the Navy construction program. He declared that the Navy has found that the cost-plus-fixed-fee type of contract has worked out to best advantage on Navy work and there is no thought of changing to any other method. Speed in construction costs money, he pointed out, and therefore the cost of Navy work under the fast construction schedules demanded has not been out of line.

The Navy construction program for 1942 is double that of 1941, and now is being carried out at the rate of $85 million per month. This, however, must be stepped up to $130 million per month. Commander Dunlap said the Navy will try to use as many small contractors as possible but such use must not increase the cost or difficulties of administration.

WPB operations

The changeover from the Office of Production Management to the War Production Board was discussed by W. V. Kahler, chief, construction branch, War Production Board. Specifically, he said, there has been formulated a new bureau of field operations into which has been merged the overall and administrative functions of the field offices heretofore maintained by the priorities field division and contract distribution division. Under the new setup policy decisions on priorities will continue to be made through the bureau of priorities, in Washington, while policy decision in the subcontracting field will be made in the division of production, under Mr. Harrison, to whom the former division of contract distribution was transferred. Policy matters affecting field procedure will all be handled through the new bureau of field operations.

No change of consequence has been made in the work of the several construction branches, and as far as he knew, Mr. Kahler stated, these branches will continue to function as in the past. These four principal departments concerned with construction are: (1) defense housing under C. F. Palmer; (2) government requirements under Maury Maverick; (3) civilian construction under John L. Haynes, and (4) construction of the production division, under Mr. Kahler, which looks after military construction—that is, war and navy work and government-financed industrial plants.

In measuring the size of the war construction program, Mr. Kahler said: "All told, the program is now made up of some 5,000 projects, about 3,400 of which are underway, and about 1,600 of which are complete. The exchequer is being filled at the rate of about $515 million a month by appropriations and contract authorizations, but the outflow is at the rate of only $475 million a month. We can look forward into the next several months and see an increase of something like $500 million or better a month. This tempo will continue through the next 10 or 12 months, Mr. Kahler believes.

Defense housing progress

Baird Snyder III, acting administrator of FWA, spoke on war time housing. He pointed out that although housing was

"Springboard to victory"

In speaking of the size and the cost of the present war construction program General Reybold said, "The cost of so much of this program as now definitely authorized aggregates $6 billion. That the future will demand future billions is not to be doubted. Of the total authorized, something like 56 percent now represents completed work. Even in a day of astronomical figures such a one as I have quoted commands respect. But perhaps even more impressive than the figure is the thought that this $6 billion worth of construction underlies the entire war effort. The cantonment, air field, factories and other facilities represented in our program must be on hand before the multi-billion program of armament and army training can proceed. The engineer-contractor team is, so to speak, the springboard to victory."

needed during World War I, actually no projects were completed at the time the Armistice was signed. By way of contrast, he said, FWA statistics of Jan. 23, 1942, show that 443 projects for 136,715 dwelling units have been assigned for construction; 327 projects embracing 88,404 dwelling units were under contract and 221 projects embracing 51,433 dwelling units have been completed.

Frank W. Herring, assistant director, National Resources Planning Board, reviewed the history of the various programs during the past decade to stimulate employment through construction with funds largely provided by the federal government. One disturbing factor in the last PWA program, he pointed out, was the fact that as federal spending for construction was stepped up municipal and state spending rapidly fell off, thus largely nullifying the effect of the federal money. He believes the reason the employment stabilization program of 1933–39 fell far short of perfection can be summed up in two reasons: (1) inadequate preparation, and (2) failure to formulate a long-time policy for dealing with the problem of unemployment. Continued Mr. Herring:

"Programming of public improvements is in effect long term capital budgeting. The absence of proper planning may yield a schedule of anticipated construction activities all right, but the activities themselves may be inadequately related to future needs. Consequently, the quality of the program that is formulated is highly dependent on a strong support of community planning. Only through the planning process can we be assured that the projects included in a program will yield a maximum of social good in return for the expenditures made upon them."

A. P. Greensfelder, chairman of the market development committee of the AGC, also discussed post-war projects.

Labor relations

Concern was expressed by many in attendance over the uncertainties of the construction labor situation. Particularly distressing was the fact that, under the OPM-AFL labor stabilization agreement, organized labor works for time-and-a-half for all time over 40 hr. per week and on Saturdays and Sundays on war projects "financed and directed" by the federal government, but the agreement apparently does not apply to privately-financed projects even though they are being built solely for war production. On such projects double time for overtime and Saturday and Sunday work prevails, which is disturbing the labor situation in localities where both types of plants are under construction.

Paul Wooton, Washington correspondent for McGraw-Hill Publications, and Gov. Henry F. Schricker of Indiana were speakers at the annual banquet, at which E. P. Palmer was toastmaster. Mr. Wooton outlined the war effort as gleaned from recent interviews and press conferences in Washington. Gov. Schricker spoke of the job ahead to win the war, pleading for all citizens to shake off their lethargy and wake up to the fact that America is fighting for its very existence.

New officers elected

Dan W. Kimball, Owens-Ames-Kimball Co., Grand Rapids, Mich., was inducted as president of the AGC for the coming year. Oscar B. Coblentz, McLean Contracting Co., Baltimore, is the new vice-president. Following are the divisional chairmen and vice-chairmen: Highway, J. H. Pittman, Houston, Tex., and Wm. Roscoe, Billings, Mont.; heavy and railroad, Lester C. Rogers, Chicago, and A. Teichert, Jr., Sacramento, Calif.; building, Wm. Muirhead, Durham, N. C. and Paul Fogel, Kansas City, Mo. J. A. Higgins, Cincinnati, is the new chairman of the secretaries council.

Better concrete for ordinary jobs emphasized on convention program

American Concrete Institute meeting in Chicago reports codes of good practice. R. E. Davis succeeds Admiral Moreell as president

Evidence that the American Concrete Institute has assumed a responsibility for raising the quality of concrete used on the ordinary job was apparent on the program of the 38th annual convention held in Chicago Feb. 18-20. It took the form of four committee reports presented as codes of good practice and covering (1) design of mixes, (2) measuring, mixing and placing, (3) inspection, and (4) use of metal supports for reinforcement. In addition to these code-type papers, others covered such important problems as absorptive form linings, masonry wall practices, and concrete disintegration resulting from aggregate-alkali reactions. The only war notes were registered by a paper on saving steel in reinforced concrete design by R. L. Bertin and another on the use of architectural concrete on the naval medical center near Washington (*ENR* Oct. 23, 1941, p. 576) by Capt. Hugo C. Fischer, assistant director of construction, Bureau of Yards and Docks, U. S. Navy.

Another and potent reminder that we are at war, however, was the address of the retiring president Rear Admiral Ben Moreell (CEC) USN, Chief, Bureau of Yards and Docks, which was delivered by telephone from Washington. Admiral Moreell stressed the gravity of the war situation and urged the Institute members to devote all the energy that they can muster to every task that is presented to them in the days immediately ahead.

Prof. Raymond E. Davis, University of California, was elected president for 1942. Vice presidents are Prof. M. O. Withey, University of Wisconsin, and R. W. Crum, director, Highway Research Board. A new member was added to the board of directors in the person of A. B. Cohen, consulting engineer, New York.

All of the papers presented at the convention have been published in the Institute *Journal*. It is only necessary, therefore, to emphasize their contents briefly and to point out the pertinent discussion.

Absorptive form lining

Success continues to attend the use of absorptive form lining, (*ENR* July 6, 1939 and Jan. 4, 1940), according to R. F. Blanks of the U. S. Bureau of Reclamation; and not only the Bureau of Reclamation, which pioneered its development and field use, but the TVA, the Army Engineers and state highway departments now have experience records. Costs have varied from 3½ to 5c. per sq. ft. for the absorptive wallboard itself and from 8 to 15c. per sq. ft. for installation. The material can be used only once. Studies are continuing, aided by the manufacturers, to produce a lining that is less susceptible to handling damage and to eliminate changes than the presently available types.

Importance of aggregates

That concrete qualities, particularly durability, are greatly affected by the type of aggregates used was brought out in a number of papers. J. C. Pearson, (Lehigh Portland Cement Co.), cited a cast stone failure that he thought might have been caused from using an aggregate with a low thermal coefficient, on the order of 0.000002, in combination with a cement paste whose coefficient was perhaps 0.000007; under freezing and thawing, differential expansion could have ruptured the concrete. Discussion centered on the importance of taking thermal coefficients into account in mix design. H. S. Meissner, Bureau of Reclamation, suggested that the lack of durability noted in heterogeneous rock might be accounted for by the differing expansion coefficients of the component parts. Prof. M. O. Withey pointed out that aggregates having low thermal coefficients sometimes have to be used, and said a solution might be found in making the paste able

to take expansion movements, that is, giving it a certain ductility. M. A. Swayze (Lone Star Cement Corp.) called attention to the fact that some rocks, notably calcite, have different coefficients for the major and minor axes of a particle, which complicates the problem of expansion even more.

Latest experience in California with the problem of concrete deterioration as a result of a chemical reaction between alkali in the cement and some minerals in the aggregates was outlined in a four-part paper by Thomas E. Stanton, O. J. Porter, L. C. Meder and Allen Nicol, all of the staff of the California division of highways. No satisfactory accelerated test to detect dangerous aggregates has yet been devised. Petrographic analyses are believed to offer a fertile field for isolating rock types that are apt to cause trouble. Because of the difficulty of detecting bad aggregates, California has placed a limit of 0.6 per cent alkali content in the cement that it uses, and by this means has succeeded in eliminating deterioration. The one mineral that has been defintely proven to be highly reactive to high alkali cements is opal which is widely encountered in California aggregates.

In discussion on the subject, Mr. Meissner emphasized that the alkali-aggregate reaction trouble is not confined to California but is a potential danger in many parts of the country. Since no test is available to weed out bad aggregates, Mr. Meissner sees no alternative but to limit the alkali content of the cement. The Bureau of Reclamation is carrying on extensive laboratory studies of 30 cements of different alkali content, and this work is being supplemented by the examination of failed structures and the materials that have gone into them.

Prof. Roy O. Carlson (Massachusetts Institute of Technology) pointed out that temperatures of 100 to 110 deg. give best results in accelerated expansion tests. Tests that he has conducted indicate that the smaller the aggregate the greater the expansion; that sodium sulphate gives greater expansion than an equivalent amount of sodium hydroxide; and that small amounts of aluminum powder in the paste reduce expansion. M.I.T. tests also show that mica should be added to the list of materials that show excessive expansion.

Prof. C. H. Scholer (Kansas State College) described concrete expansion difficulties that have been noted in the Missouri valley which, however, are apparently not associated with high alkali cement. Most of the damage occurs in mixtures deficient in coarse aggregates.

Codes of good practice

The several new codes of good practice presented to the convention for discussion before formal adoption by letter ballot were in general well received. Considerable dissenting discussion attended the recommendation that mix design strengths be governed almost wholly by the water-cement ratio, the contention being that the type and grading of aggregates governed what strength a given water-cement ratio would produce. Those favoring the codes argued that their value lay in their simplicity; while it was possible to expand the instructions greatly, the ordinary job contractor would not welcome a voluminous set of rules either for designing mixes or for inspection.

The new inspection manual was especially commended and brought out extensive discussion of the importance of the inspector. A. B. Cohen, consulting engineer, New York City, suggested that the inspector should be called "job engineer," "job supervisor" or "control engineer" in order to define his status more accurately. He pointed out that the logical route of advancement for an inspector was in the contractor's organization; in other words, he should develop into a job superintendent rather than an office designer, as is too often the case.

The codes of good practice were developed by a procedure in which an author-chairman prepares the code which is then criticized and revised through discussion with committee members. Author-chairman for the recommended practices for measuring, mixing and placing concrete was Lewis H. Tuthill, U. S. Bureau of Reclamation; for the inspection manual, J. W. Kelly, University of California; for the recommended practices for the design of concrete mixes, R. F. Blanks, U. S. Bureau of Reclamation; and for recommended practices for the use of metal supports for reinforcement, William F. Zabriski.

Long-time cement study

A rate of progress that was surprising to everyone present was reported by F. R. McMillan, director of research, Portland Cement Association, for the long-time study of cement performance in concrete that is under the direction of a committee of twelve, eight of whom are from outside the cement industry while four represent cement manufacturers. Investigation is divided into three parts, (1) collecting the cements and determining their complete manufacturing history; (2) building various structures using the cements and noting their durability over a period of years; and (3) extensive laboratory studies. By June, 1941, 100 barrels of each of 27 cements had been collected ready for every possible kind of test. Some 24,000 separate containers have been required for the samples.

For the second part of the program, test roads utilizing all of the cements have been completed in Andrew County, Mo. and near Greenville, S. C. while a third is scheduled for construction in New York this spring. In addition the committee has constructed a large number of test specimens on two fa[illegible] one in the Chicago area and one in [illegible]rgia. Specimens consist of slabs, holl[illegible]boxes and columns. Many combina[illegible]s of mixes have been used, the tot[illegible]eing about 80, counting the test roa[illegible]ixes. Tests for seawater exposure a[illegible] also planned for Buzzards Bay, M[illegible] St. Augustine, Fla., Passamaquoddy, [illegible]laine, and Los Angeles, Calif.

Saving steel

In a paper on saving steel in rein[illegible]rced concrete design, R. L. Bertin, chi[illegible] engineer, White Construction Co., New [illegible]ork, urged that the various ACI com[illegible]ittees reconsider the regulations for whic[illegible] they are responsible and modify them [illegible] the fullest extent consistent with safety. Discussion brought out the fact that Institute procedure made such change[illegible] impracticable when the time element was taken into consideration. Just what the Institute will do was left up to the board of directors. Mr. Bertin urged some liberalization of working stresses, in which connection he mentioned the desirability of producing high-yield-point bars. In columns the use of spirals as well as high percentages of vertical steel should be discouraged, in his opinion. Tied columns following the requirements of New York City give very satisfactory results. Another recommendation was that live loads might well be increased for temporary structures. It is also possible to effect considerable saving in steel by making piles, footings, retaining walls and similar structures out of plain instead of reinforced concrete. Mr. Bertin's basic plea was to "let the concrete do all the work it is capable of doing."

There were many discussions of Mr. Bertin's paper, but as one discussor (Lane Knight, Master Builders Co., Toronto) pointed out, they related largely to practices on multi-story structures, few of which are involved in our present emergency construction program. He urged that the Institute develop a recommended design for single story industrial structures built of concrete in which the reinforcing steel would be scaled down to the minimum. Another discussor, Prof. Dean Peabody, Jr. (Massachusetts Institute of Technology), expressed a fear that emergency changes might become permanent. On the other hand, he felt that if a single nation-wide code should come out of the present emergency, it would constitute a step forward. T. Germundsson (Portland Cement Association), suggested that a saving in steel could be accomplished safely by taking design dead loads as 75 percent of the actual. Studies made by the Portland Cement Association also indicate that the use of tied columns will save steel. As to type of floor, flat slabs use the least steel, while one-way slabs are next on the list. Prof. M. O. Withey pointed out that unit stresses in slabs and beams are now suf-

ficiently high and that to increase them would cause cracking and consequent steel corrosion. Columns using high yield point steel, however, would be satisfactory. Lightweight aggregate would afford some decrease in dead load. In general, Professor Withey felt that it was better to change methods of design and use sizes of members that are not economical rather than to raise unit stresses. It is also possible to use bessemer and other low grade steels for bars and mesh reinforcement, he pointed out. Pre-stressing of steel was also suggested by several as a means of conservation. Prof. F. E. Richart (University of Illinois), suggested that a good many conservation measures could be practiced and still stay within the present code. For example, use welded splices, deeper beams and slabs, and continuous bars and higher strength concrete in columns.

Miscellany on better concrete

A quiz session, at which R. W. Crum acted as master of ceremonies to elicit answers to prepared questions from members of the audience, furnished both fun and information. For example, it was brought out that because the use of light-weight aggregate permits a dead load reduction of about one third, use of concrete made with such aggregate may offer a way to save steel. Saving is possible, however, only in axially loaded members; flexural members may take more steel than with stone concrete. Also, although steel may be saved, money economy may or may not result since more cement will probably be required for the light-weight concrete.

Another question brought out the fact that stockpiling of aggregates is usually beneficial because it permits better moisture control. Bleeding of concrete was defined as sedimentation, in answer to a third question. Its severity is determined by the relation of the amount of water to the total surface area of the solids, and it may be reduced either by reducing the water or increasing the surface, that is, using more fines.

The answer to a question as to whether pumping a lean mixture under concrete pavements would increase their load carrying capacity was "No." Rather, a rich mix should be used at the pavement joints to give them good bearing, followed by adding material to the surface to increase the slab thickness.

Whether freezing harms concrete was not definitely settled by answers to a question on that subject. A majority of the speakers believed that if the concrete freezes before it sets, it can later be thawed to a plastic state and allowed to set and cure normally without harm. Expert dissent to this view was, however, expressed. The subject was dismissed with the warning that freezing does concrete no good.

War likely to delay Potomac River bridge

Construction of the $2,125,000 Sandy Hook Bridge across the Potomac River near Harpers Ferry, Va., may be delayed until after the current war, Ezra B. Whitman, chairman of the Maryland State Roads Commission, has announced.

The bridge, part of a tri-state road development by Maryland Virginia and West Virginia, is already in its initial construction phase, with substructure operations under way. The 2,230-ft. bridge will cross the Potomac between Washington County, Md. and Loudon County, Va.

Detailing reasons for probable delay in completion, Mr. Whitman said that the state of Virginia, which was to pay a part of the cost of the bridge, has refused to approve award of contracts on the grounds that bids submitted were too high. He said also that the project has not been certified as vital to defense by either the War or Navy departments and that without such certification it is virtually impossible to obtain priorities for the approximately 2,000 tons of steel needed.

Under the tri-state plan, Maryland was to build approaches to the north end of the span; Virginia was to build approaches in that state, and West Virginia was to bridge the nearby Shenandoah River and construct a road from its span to Harpers Ferry.

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Bridge engineers plan to save critical materials

A fifteen point program for conserving critical materials in highway bridge design is being considered by the bridge engineers of all of the state highway departments, and a number of the proposals have already been put into practice. The program, suggested by OPM, was drawn up by Raymond Archibald, of the Public Roads Administration, and submitted to the committee on bridges and structures of the American Association of State Highway Officials, of which Mr. Archibald is chairman. Although some loss in economy will probably attend use of some of the suggestions, the resulting saving in critical materials is believed to be worth the sacrifice.

It is intended that the program be operative only for the duration of the emergency. The PRA, it is understood, will approve plans on federal-aid projects whose designs incorporate any or all of the suggestions. The fifteen suggestions follow:

1. Reduce the allowable unit working stress of concrete f_c to 700 psi., this working stress to apply to all classes of concrete which have an ultimate compressive strength of 2,400 psi. or better. Some economy can be gained by reducing the amount of cement required in the richer mixes now used. An exception to this would be where it would increase the dead load to such an extent as to require a greater amount of steel, such as a concrete slab on a long steel span.

2. Use a value of $n = 10$ for most concrete and 8 if 4,000-lb. concrete is secured.

3. Use reinforced concrete in place of steel in bridge guardrails, I-beam, spans, etc.

4. Make full use of the composite action of concrete floors and beams by using mechanical anchors between floor and beams.

5. Use an allowable working stress f_s for reinforcing steel of 22,000 psi. in culverts, abutments, piers, columns and practically all substructures, specifying intermediate grade steel. This would probably call for a more liberal use of waterproofing.

6. Replace heavy steel expansion dams where practicable, with lighter steel design and concrete cross beams.

7. Discourage the use of steel grid floors except in repair jobs and movable spans.

8. Eliminate the use of copper water stops, bronze expansion plates or any copper alloy. Sheet lead can be substituted in some cases.

9. Eliminate the use of aluminum paint and all galvanizing except perhaps galvanized cables and hardware in timber bridges.

10. Eliminate the use of all alloy steels, including silicon.

11. Eliminate the use of steel bearing piles for friction piles.

12. Make greater use of treated timber.

13. Substitute small concrete culverts or concrete pipe in place of corrugated iron pipe culverts.

14. Avoid the addition of reinforcing steel to take compressive stresses in concrete members.

15. Repair existing structures, if practicable, rather than replace them with new structures.

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State engineer board organized in Missouri

The State Board of Registration for Architects and Professional Engineers for the state of Missouri, created by an act of the state legislature Aug. 2, 1941, has been organized and is now receiving applications for registration. Forms are obtainable from Roy Averill, secretary-treasurer of the State Board of Registration, Box 184, Jefferson City, Mo.

The engineering division of the board consists of Frank Beard, chairman; Ernest E. Howard and W. W. Horner.

OBITUARY

Reginald Pelham Bolton, 85, consulting engineer and president and chairman of the board of the Electric Meter Corp. of New York, died in New York Feb. 18. A native of London, England, Mr. Bolton came to the United States in 1879 and became successively consulting engineer to the department of water supply, R. H. Macy & Co., Inc., the Grand Central Terminal, and many other companies. Mr. Bolton was an authority on the history of New York in Colonial and Revolutionary times.

Ernest McCulloh, 76, a life member of the American Society of Civil Engineers and formerly an engineer for the Charles L. Pillsbury Co., died at his home in Minneapolis, Minn., Feb. 16.

Archibald M. Philleo, 50, senior engineer, Dallas district, Corps of Engineers, died Feb. 15 at Dallas. He had been attached to the Denison district office until 1941 when he was transferred to Dallas.

William Davidson, 62, assistant construction engineer for the Hydro Electric Power Commission of Ontario, died Feb. 16 of injuries received the day before when he was struck by a skidding tractor.

Abraham J. Halford, 82, chief engineer of the Ontario department of public works, died at Toronto on Feb. 14. He retired as chief engineer of the department in 1934.

Willard Close Northup, 59, of Winston-Salem, N. C., an architect, died Feb. 14.

Charles A. Hendrix, 78, building contractor of Greensboro, N. C., died Feb. 15.

George J. Duncan, 71, former public works inspector for the city of Milwaukee and specialist in harbor work, construction of docks, piers and other port facilities, died Feb. 15.

Thomas W. W. Parker, chief engineer of the Rayner Construction Co., Ltd., of Toronto, died Feb. 11 in Montreal.

Oliver E. Crouse, 62, Sunbury, Pa. contractor, died Feb. 11.

Ira Schoonover, 60, of Paterson, N. J., engineering contractor who played a prominent part in rehabilitation work in the Philippines, died at Paterson Feb. 11. A student at the U. S. Military Academy at West Point, Mr. Schoonover left before graduation to enlist in the Corps of Engineers and remained in the Philippine Islands until 1902.

John W. Tillson, 82, of Omaha, Neb., a civil engineer with the Union Pacific Railroad for 48 years, died recently at Omaha.

Byron T. Mottinger, 62, professor of engineering at Youngstown College, Youngstown, Ohio, died Feb. 10.

Willis E. Myers, 78, of Warren, Ohio, former head of the engineering school of the University of Ohio, died Feb. 7 in Youngstown.

Matthew P. Platten, 73, pioneer in the cement construction business, died Feb. 6 at Cleveland, Ohio.

James C. King, 66, Winchester, Ind. building contractor, died recently after an automobile accident near his home.

Waldo F. Walker, 55, of Columbus, Ohio, chief assistant engineer of maintenance in the state highway department, died Feb. 19 at Lima.

Edwin L. Linzell, 39, chief deputy in the office of the Franklin County, Ohio, engineer, died at Columbus Feb. 16. He had been employed by the office for five years.

Charles A. MacDonald, 60, retired civil engineer of Penfield, Pa., died Feb. 17.

Frederick H. Jeffrey, 65, construction engineer of Lachine, Que., died Feb. 17 at Montreal, Canada.

Frank L. Packard, 65, civil engineer, died Feb. 17 at Lachine, Canada.

CONTRACTS AND CAPITAL

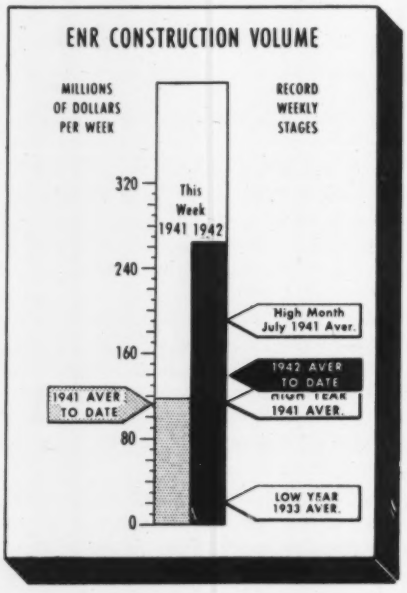
MAJOR ENGINEERING construction awards for the short week due to the Washington's Birthday holiday total $266,622,000, the highest weekly volume reported this year. This volume is 161 percent greater than last week and 124 percent greater than the corresponding week in 1941.

Public construction totalling $253,618,000 is also the highest reported this year, comparing with $75,528,000 reported a week ago and $82,006,000 reported in 1941. Federal awards at $248,143,000, the highest volume reported since July 10, 1941, are responsible for this large public construction total.

The current week's total brings 1942 construction to $1,263,603,000, an increase of 25 percent over the volume reported for the same period last year.

In the classified construction group, gains over the preceding week are in public buildings, waterworks and unclassified construction. Subtotals for the week in each class of construction are: waterworks, $6,798,000; sewerage, $1,211,000; bridges, $494,000; industrial buildings, $2,606,000; commercial building and large-scale private housing, $1,160,000; public buildings, $226,327,000; earthwork and drainage, $511,000; streets and roads, $3,036,000; and unclassified construction, $21,479,000.

New construction financing for the year totals $1,372,463,000 compared with $679,711,000 for the same period last year.



CONTRACTS

(Thousands of dollars)

	Week Ending Feb. 27 1941	Feb. 19 1942	Feb. 26 1942
Federal	$51,025	$62,995	$248,143
State & Municipal	30,981	12,533	5,475
Total public	$82,006	$75,528	$253,618
Total private	37,195	26,690	13,004
TOTALS	$119,201	$102,218	$266,622
Cumulative 1942 (9 weeks)			$1,263,603
Cumulative 1941 (9 weeks)			$1,008,818

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1941 9 weeks	1942 9 weeks
NON-FEDERAL	$170,111	$130,508
Corp. Securities	52,750	28,832
State & Mun.	77,970	87,847
U.S.H.A. loans	13,521	...
R.F.C. loans	25,870	13,829
FEDERAL	$509,000	$1,241,955
TOTAL CAPITAL	$679,111	$1,372,463

ENR INDEX NUMBERS

		1913	1926
Index Base = 100			
Construction Cost	Feb. '42	269.41	129.51
Building Cost	Feb. '42	218.44	118.08
Volume	Jan. '42	503	221

FHA MORTGAGES

	Week Ending Feb. 21 1941	Feb. 14 1942	Feb. 21 1942
Selected for appraisal			
Title II	$28,046	$15,954	$16,631*
Title VI		$20,162	$21,511*

* Subject to revision.

Comment and Discussion

Readers' opinions on matters that concern engineers and contractors

The Problem of Waterproof Concrete and Rusted Rods

Sir:—During the past few years I have had occasion to examine a good deal of concrete work from ten to twenty years old. I find a great deal of this work in bad condition due to rusted reinforcing rods and consequent spalling. This condition is observed largely, but not exclusively, in concrete work exposed to the change of weather.

In every case where rusted rods were found exposed there was good evidence that water was seeping through the mass, usually from above, though in some cases, laterally. In my own opinion, in every case the fault is due to water, and in nearly all cases could have been prevented by using a waterproof concrete.

When I consider our present-day concrete methods I find a wide variety of opinion and practice not only as to the best means of waterproofing but, apparently, without bothering with waterproofing at all, unless it is to prevent water from entering interior structural spaces. Apparently a good many engineers have not looked under reinforced concrete structures and seen the vital damage being done to their steel rods.

Among engineers who appreciate the importance of waterproofing for the purpose of protecting the steel, there is a wide variety of opinion on the best or most expedient methods of waterproofing. A good many engineers feel that a well-prepared mix, properly vibrated and placed, is sufficient. Other engineers feel that some admixture is necessary, though they are not at all in agreement as to the best admixture. Still other engineers think that water will enter exposed structures in any case and that the important, most vulnerable, steel should be galvanized. In passing, I note that the handrail steel on the new Jacksonville, Main Street Bridge, was galvanized prior to its erection.

If our reinforced concrete structures are to have such a reasonable life as fifty years, then the vital steel must have protection for that time, and thorough waterproofing appears to be the only means of giving it such protection. It seems to me that the subject warrants very careful examination and a definite expression of opinion by some reliable, disinterested body.

M. P. HITE
Senior Civil Engineer
U. S. Coast Guard
Jacksonville, Fla.

Designing Reinforced Concrete Beams by Column Analogy

Sir:—A letter by Andrew Eberhardt (*ENR*, Jan. 1, 1942, p. 8) contains some comments on the writer's article "Designing Reinforced Concrete Beams with Variable Moments of Inertia" published in the Nov. 6, 1941 issue. Mr. Eberhardt states that "some generally known methods seem to work faster and better," thus inferring that the author has presented something new.

The writer's article contains nothing original except perhaps the display of smbols in Eq. (5) in two groups, $\frac{\Delta x}{I}$ and $\frac{Mx}{I}$. This grouping and a table similar to Table I for uniform and uniformly varying loads are the work of Justin Nicolet, of the design staff of the Department of Subways and Superhighways, Chicago, who, in the writer's opinion, is one of the ablest structural engineers in America. The solution is the author's.

Mr. Eberhardt states that the problem can be solved by "column analogy" in somewhat less time, but that the results will be somewhat different because of the automatic inclusion of side sway, for which the author's method does not provide. Had his "close investigation" been a trifle closer, Mr. Eberhardt would have observed that side sway might be considered simply by including the term ψ with the proper coefficient in Eq. (10) to (13) as shown in Eq. (10a) and (10b).

The reference to "column analogy" with side sway included leads the writer to suspect that Mr. Eberhardt's proposed method is nothing more nor less than the application of the standard theory of arches. Whether such a solution works faster and better is a matter of opinion, especially when confronted with the frame in Fig. 4.

CHARLES A. ELLIS
Professor of Structural Engineering
Purdue University
Lafayette, Ind.

Air Lift for Artificial Drainage Duty in Underpasses

Sir: The article, "Requirements for Artificial Drainage at Highway Grade Separations," by Benesch and Whannel (*ENR*, Oct. 9, 1941, p. 499) indicates that the authors have taken care of all ordinary contingencies, but I have seen enough underpasses fill up to know that sometimes the best of plans go awry.

In that case an air lift is indicated. It is hard to beat for cheapness, reliability and simplicity, and the efficiency is good enough. All you need to do the job is a pipe and a portable compressor.

I am unable to refer to any design data, as the literature starts at 25 ft. and runs down to 2500 ft. The underpass lift starts at zero when the pass is full and will hardly go over 25 ft. as a maximum, but if it does it is easily taken care of. I have seen a 20-ft. length of 10-in. pipe two-thirds submerged, deliver 1,000 g.p.m. with a 200-c.f.m. compressor.

The lift will work at reduced capacity down to one-third submergence which can be obtained in most underpasses with reasonable depth sumps. If used much at this depth, however, it would be more desirable to make a small sump installation, thus obtaining the benefit of more submergence.

The lift will pump any combination of sand or mud that you can get to it or away from it. No elaborate air head is necessary as an air pipe down the center of the water pipe with perforations at the bottom to break the air into small bubbles is all that is necessary. The air should be allowed to separate from the water at the top and the water handled in open conduit.

WALTER B. CANNON
Hollywood, Calif.

EDITORIALS

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Works Planning Postponed

ANOTHER important engineering activity felt the impact of war last week when Congress voted against supplying funds for post-war public-works planning. It is difficult to find any fault with the decision. Important as it is to have plans and designs ready to go once peace returns again to the world, it is more important now to get the war running in our favor. Until a fire is under control and the approximate limits of its destruction determined, it is a waste of precious energy to start detailed rebuilding plans. The war is out of control at the moment. Decisions are running heavily against us. Until the trend is reversed, war must take all the manpower, money and materials that are available. Nothing must divert us from this all-important task. Like a good many other things that had an A-1 priority before Pearl Harbor, Singapore, the "Normandie" and the battle of Dover Straits, post-war planning must be postponed. War is our only business today. It must be conducted without diversions. Then, when victories once more are ours, when the fire is under control and the limits of destruction outlined, public works planning will deserve the support that Congress now must necessarily deny it.

New Vistas in Sewage Filtration

ALTERNATING DOUBLE FILTRATION, the term applied in Great Britain to a new method of operating trickling filters, provides a means of doubling the capacity of existing installations. According to published accounts, an abstract of which appears on p. 64 of this issue, the new process already has been applied at several plants in England with appreciable savings in cost and in materials of construction. The system provides simply for passing sewage through two filters connected in series; when the primary filter becomes clogged with solids after a week or so of operation, the flow is reversed so that the secondary filter takes the initial load and the clogged unit receives only filtered effluent, which removes the clogging solids. This practice maintains both filters in top-notch condition, and permits purification of twice the quantity of sewage per cubic yard normally obtained from single filtration. Not to be confused with high-rate filtration as practiced in this country, the British system must be considered as a distinctly different approach to the challenging prospect of increasing sewage-filtration efficiency. The new knowledge already gained in this respect invites the thought that we are witnessing a period of filtration development that will command as much interest as did the revival of chemical treatment a decade ago.

City Permits

"TOO MANY PERMITS are required for anything you want to build in a city," commonly complains the builder, yet still more may be added by conditions brought into focus with loss of life and destruction of property in San Francisco earlier this month. The question is whether city authorities should insist upon some supervision or control over *all* work within city limits in which deficiencies might endanger life or property. The case in point is an earth slide that started in a new fill on a hillside subdivision, as described in a news item in last week's issue. The menace involved in this and similar cases could be avoided, city authorities point out, if adequate and proper methods had been used in making the original fill. How shall necessary supervision be secured without imposing onerous restrictions or undue limitations? Perhaps failure of the St. Francis Dam constitutes a parallel; that disaster focused attention on the need for having plans for all dams, exceeding a stipulated minimum, passed upon by state authorities. Similarly, it should be possible to put into city ordinances the requirement that *extensive* improvements such as fills, retaining walls, stream channels, etc. on private property must have the plans checked and approved. Despite the dangers in and objections to increasing red tape and municipal overhead, the leaning is toward requiring this additional form of city supervision.

Are Conventions Justified?

THE LOUDEST SIGNAL yet for merciless weeding out of activities not essential to the war effort was sounded by the grim tone of last week's communiques. It must now be clear that each old habit, each new proposal, must measure up fully or be abandoned for the duration of the emergency. Among the old habits are national conventions of engineering societies, and their justification under present conditions demands close scrutiny. Those

conventions held so far this year have not been too successful in establishing their vital necessity, despite valiant efforts on the part of the program planners to confine the papers to current problems. Prospective authors who could prepare useful papers are too busy on war jobs or are concerned with operations whose details cannot be divulged for military reasons. Furthermore, attendance has been neither representative nor large, either because of the difficulties and expense of travel or because time cannot be spared from the job. Since the situation in these respects is going to be worse before it is better, convention plans should be analyzed quite ruthlessly. The real contribution of engineering societies to the war effort comes from the activities of their committees in preparing emergency specifications and codes of practice, in bringing about concerted action on specific problems, in giving aid and guidance to Army, Navy and government officials. This vital work must be kept up and expanded. The need for formal national conventions is much less clear. Unless it can be proved, conventions should be abandoned as a waste of valuable time.

Rather Confusing

THE CITY ENGINEER of Rome, N. Y., does not need to be licensed to practice engineering, according to a ruling by the State Education Department which administers the engineer license law in New York. How come? Well, the assistant city engineer is a licensed professional engineer, and when there is engineering work to be done he can do it. This is rather confusing. And the confusion is increased by the admonition of the Education Department that if the city engineer is caught actually engaging in engineering, prompt action will be taken. The New York State law says: "A person practices professional engineering who holds himself out as able to perform, or who does perform, any professional service such as consultation, investigation, evaluation, planning, design, or responsible supervision of construction or operation, in connection with any public or private utilities, structures, buildings, machines, processes, works or projects wherein the safeguarding of life, health or property is concerned or involved, when such professional services require the application of engineering principles and data." From which it is clear that the new city engineer of Rome is in for a busy time just avoiding engineering.

Substitutes May Stay

RECENT SUCCESSES attending the use of so-called substitutes for materials that are no longer abundantly available suggest that some of the new designs may turn out to be more than just temporary expedients. It might, therefore, be the part of wisdom to assume that any substitute is here to stay, and to analyze and study it with such possibility in view.

Molybdenum, for example, is being used as an alloy in high-strength structural steels. Is it as good as nickel or silicon or manganese for this purpose? What changes in design or fabricating practice are required with molybdenum-bearing steels? For protection against corrosion, metal surfaces have been given a phosphate treatment followed by painting. How does this compare in cost and efficiency with galvanizing? The number of available sizes of structural steel shapes has been reduced. If it should be decided to adhere permanently to such a simplified list, what changes in design practice would need to follow? Treated timber, using both creosote and clear preservatives, has demonstrated its worth in many war-period applications; offering long life and substantial fire resistance, treated timber will bid for the designer's respect and consideration in the post-war period. And its utilization in substantial structures will be aided by metal shear connector joints. Where is timber's place in an economy that can offer concrete and structural steel, and even aluminum and magnesium in abundance? Will we be able to use timber as efficiently as its new properties permit? Copper, zinc and lead for flashing, gutters and pipe are being replaced by asphalt-protected metal, by asbestos-cement products, by plastics. If these substitutes should prove to be worthy competitors, will we know enough to use them properly and to maximum advantage?

Now, while we are forced to use these substitutes, is the time to begin answering these questions. It is, in fact, not safe to assume that they are substitutes. They may be new applications that are here to stay.

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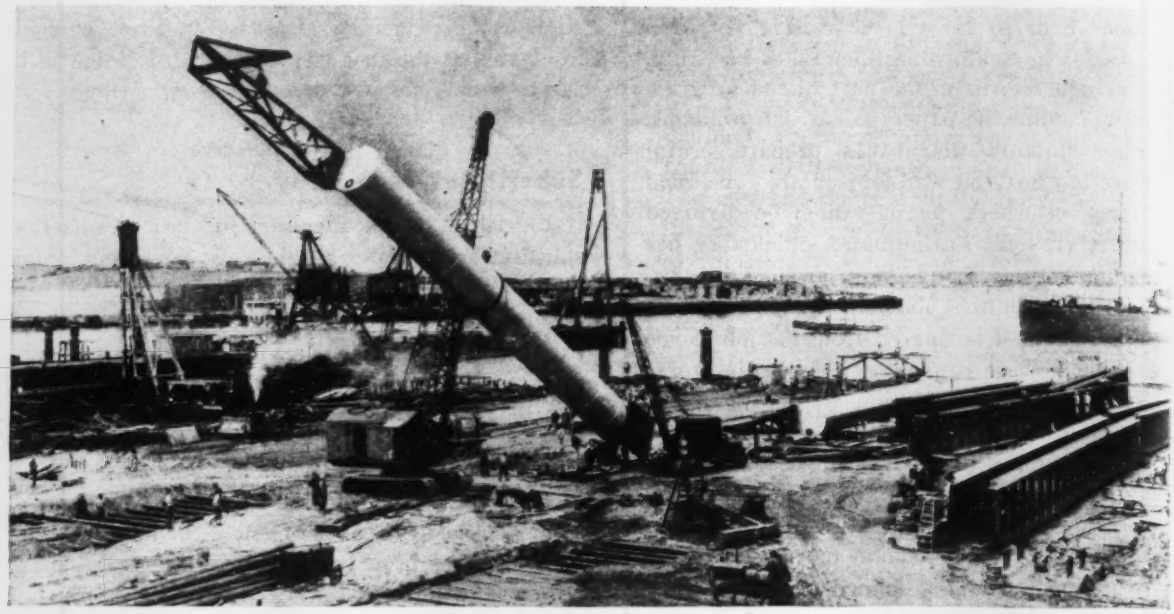


Erecting a cylinder column. Temporary gallows frame on top is used to lift the crane girders.

Cylinder Columns Carry Shipyard Cranes

***Contents in Brief**—Cylindrical steel columns, 93 ft. high and 110 ft. apart, with no braces or guys, support overhead crane rails 630 ft. long at one of the recently enlarged shipyards. The crane rails, 95 ft. apart, are designed to carry a moving load of 165,000 lb. The structure is designed with allowances for horizontal forces of 0.2g.*

WITHOUT PRECEDENT as a guide, unbraced column supports have been used for overhead cranes at a shipyard where clearances were limited by reason of the desire to utilize piling already in place. The columns are cylindrical in shape with bases firmly bolted to a concrete slab capping a cluster of wooden piles. The structure supporting each crane rail is thus a row of vertical cantilevers tied together at the top by a continuous steel girder 630 ft. in length supported at six points 110 ft. apart and having a 40-ft. overhang at each end.

At this yard there are to be three shipways; two are already built and a third is under construction. Columns supporting the overhead crane are the same on outer and inner rows but the continuous girders are doubled on those rows of columns that support two crane rails. In other words, each crane rail has its own supporting girder. Where two girders are put on the same row of columns, the webs are interconnected by bracing to gain the added stiffness of what is virtually a box girder. All parts of this steel structure are welded. It is said that "there is not a rivet on the job."

In planning to build shipways to carry out Navy contracts at this yard, it was found that the pile foundations, put in some 25 years ago for constructing ships of lesser width than those now wanted, could again be used provided the structure supporting the overhead cranes could be designed to occupy only the limited space that would be available between the ships of greater beam now planned. The cost that would be involved in widening the old foundations and the probable delay in getting materials made it highly desirable to devise means of carrying the overhead cranes within the available space.

The limited space could be made to do, it was found, by using an 8-ft. cylindrical section for columns that would be self-supporting. With columns of this size there is just barely enough room for falsework and scaffolding on either side of vessels now under contract. Space between the ways is at such a premium that even the necessary width for a passageway to be used by workers could not be spared, and in the bases of the columns the steel plates were cut away to provide arched openings 8 ft. high and 6 ft. wide. Through these openings communicating corridors run lengthwise of the shipways. The openings are framed in structural shapes welded to the cylindrical walls to carry the load that otherwise would go through the plates that have been cut away.

Manufacture and erection

Thickness of the plates which make up the steel cylinders varies from 5/16 in. at the top to ½ in. at the bottom. The plates were rolled to a prescribed diameter of 95 in., measured to the center of the plate, which is kept the same from top to bottom, regardless of plate thickness. Each successive length of the cylinder is made up of three sections welded together. Circumferential joints are

formed by butt straps 4-in. wide whose thickness varies from $\frac{3}{8}$ in. at the base to $\frac{1}{2}$ in. at the top. These bands go on the outside of the cylinder and have continuous welds along both edges. On the inside of the cylinder the abutting plates are welded in circumferential seams for a length of 4 in. at 12-in. intervals.

The cylinders were welded together in a horizontal position on a platform equipped with rollers to facilitate turning so that welders on the roundabout joints could work to advantage. All the welding was done by hand, no automatic machines being used. On the $\frac{1}{2}$-in. plate the usual practice was to make four passes on one side and then, from the other side, to chip out the metal first placed and finish up that side with a final pass.

With a gallows frame mounted on the top for use in erecting the girders, columns were then trucked to the site and set upright on their foundations by two traveling cranes. The larger of these cranes had a 70-ft. boom, and from this the cylinder was picked up bodily from a single point of support so located that the cylinder would be raised with a "bottom-heavy" characteristic. This made it possible for the second crane to take a lift on this lower end where it could aid in lowering the base to exact position on its foundation. When ready to be lifted to place each steel cylinder weighed about 25 tons.

Anchorage at the base of the columns consists of $2\frac{3}{4}$-in. bolts. There are twelve of these in each intermediate column and 20 in the columns at either end of a row. More were required in the end columns because here a complete circumference had to be anchored down. The intermediate columns have less steel in contact with the foundation because of openings cut for the passageway. The anchor bolts are 16 ft. long; they pass through 18 in. of steel at the column base to give adequate bearing and then go down around a grillage of reinforcing embedded in the concrete. The support for each column is a group of 35 piles with a 21x26-ft. concrete cap varying in thickness from 9 to $13\frac{1}{2}$ ft. according to location with respect to the water line.

Longitudinal girders

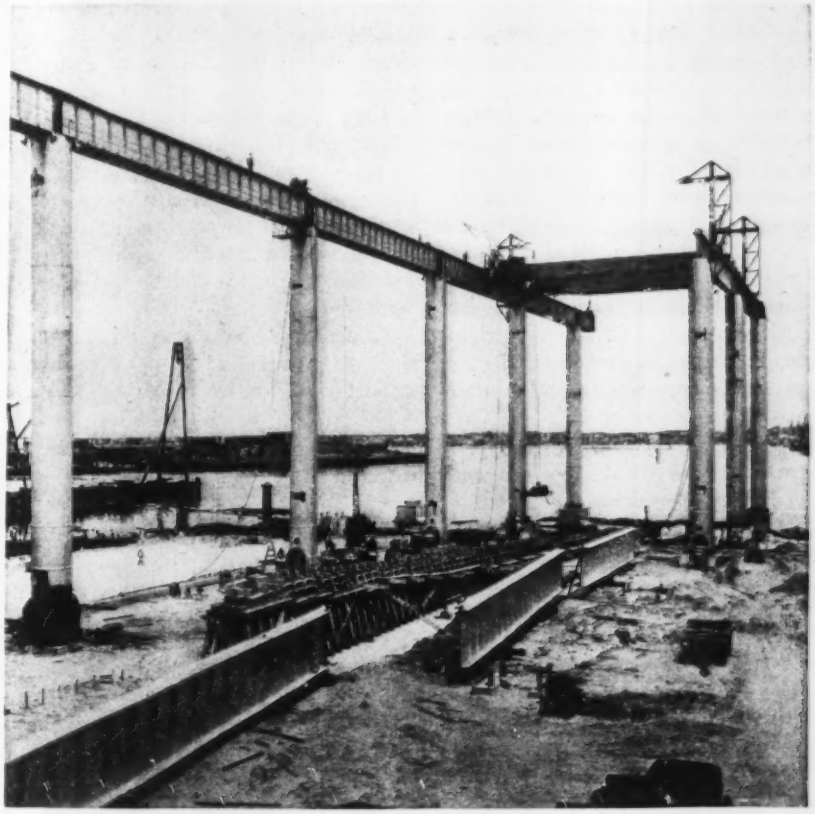
The double girders that rest on the column tops are 8 ft. 5 in. in depth; single girders, 9 ft. 3 in. are put together by welding and are figured as continuous beams over the row of columns. The design is conventional for a crane load of 115,000 lb. plus a 50,000-lb. load lifted by the crane. This requirement worked out so that the 630-ft. length of the single girders totalled 335 tons as against 596 tons for the girders set up as a pair. The latter have cross bracing every 11 ft. to make webs and flanges function as in a double web or box girder. For lifting the girders to place atop the columns, four gallows cranes were provided. This number permitted two to function as a pair while the other two were being moved ahead.

Special care was taken to avoid risk of breaking the welded connections between girder and cylinder top as the result of the almost constant swaying and vibratory motions that occur in operation. It was believed that this could be accomplished best by keeping to a minimum the leverage on such connections. Accordingly, the longitudinal girders at each column top rest upon a $\frac{1}{2}$-in. plate only 10 in. wide which extends across the column at right angles to the girder. The column top is closed by a plate $\frac{3}{4}$ in. thick on whose underside, immediately beneath the 10-in. plate, is a transverse girder stiffening the top plate and aiding in transferring the load to the cylinder walls.

Tests and distortion

Prior to erection of the girders, a test load was applied at the top of one of the columns to observe its action under bending stresses. The load was applied by a cable running diagonally to the top, pulling in a plane at right angles to the girder center line. Observations were made under supervision of Prof. R. R. Martel, California Institute of Technology, on test loads with a horizontal component of 35,000 lb. This loading produced a $3\frac{3}{4}$-in. deflection at the top of the 93-ft. column. The test results indicated very nominal stresses for a combination of dead and live loads with a horizontal thrust of 0.2 *g*.

The calculated vibrational period of the completed 630-ft. structure on which a single girder is mounted is 1.25 sec. For the row of columns surmounted by a double girder, the period is 0.96 sec. The overall period for the structure as a whole, with the crane spanning the space between the

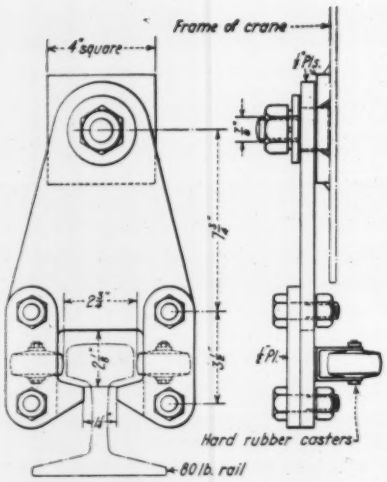


Craneway takes shape rapidly after first row of columns is completed. Note the passageway, 6 ft. wide, through bases of the columns.

two rails, is taken to be about 1 sec. Movements in the girders resultant from wind or such shock and impact as there is in crane operation are only fractions of an inch.

Maximum deflection of column tops was observed under the influence of temperature prior to the placement of the girders. With the sun shining on one side of the column, causing that side to expand, the top of the column bowed away from the sun, moving to oppose the sun's position. The orbit of rotation of the column top under this temperature influence is on the order of 4 in., i.e., 2 in. each way from the vertical. Like the columns, the girders bow, under the influence of the sun, curving away from the warmer side.

Recognizing the importance of preventing any risk of crane derailment that might be caused by operating accident or earthquake shock, keepers were welded to the frame at both ends of the crane girders in a position where they would project under the head of the 80-lb. T-rail on which the wheels move. This was not a satisfactory plan because of movement and irregularity of the track which tended to cause the keepers to bind against railhead or flange. Accordingly, they were replaced by swinging keepers attached by a pin to the crane structure and guided by hard rubber rollers along the sides of the railhead, as shown in the sketch.



Keepers of this type, referred to as "earthquake stops," prevent derailment of crane wheels.

Contract for fabrication and erection of the first two ways was carried out by the Lacy Manufacturing Co. The overhead cranes were designed by Wm. A. Sandberg. Contract for the crane over the third slip was awarded to the Consolidated Steel Co., contract also including a row of six steel columns surmounted by a single continuous girder and a second continuous girder on the row of columns already in service on the adjoining shipway.

Intermunicipal Cooperation On Airports Increases

FORTY-TWO MUNICIPAL AIRPORTS in the United States are operated as joint enterprises by 91 cities and counties, and 55 more probably will be established in the near future, according to a recent report to the International City Managers' Association. With federal aeronautics authorities declaring the number of airports must be doubled and the number of hangars tripled to meet defense and civilian requirements for facilities, the move for intermunicipal action on airports that began in the late 1920's may receive still greater impetus, the report said.

Most of the intermunicipal airport agreements are between one city and one county. Seven have been established by joint intercity action, and only four involve more than two municipalities. Twenty-two of the 42 existing joint ports are in communities below 10,000 population, and only two are in areas over 100,000.

Procedures followed in establishing, maintaining and operating joint airports vary considerably, it was pointed out. Some of the arrangements specify the responsibilities of each party in formal written contracts, resolutions or ordinances, while in other cases municipalities just "get together" without much consideration for legal forms and sharing of costs.

The airport serving Luzerne County and Wilkes-Barre, Pa., is said to be an example of the "formal" city-county arrangement. In operation since 1934, the airport is governed by a board of three members—two from the respective county and city legislative bodies and a third selected by the two. Wilkes-Barre meets all expenses incurred in the lease of the airport site, while the county pays two-thirds of the maintenance and operation costs. The ordinance limits expenditures to $18,000 a year.

Dothan and Houston Counties, Ala., have an informal agreement. Each provided half the land and together secured a WPA project to supply trucks and laborers. Houston County furnished grading equipment, and the city paid the salaries of the men and cost of fuel for operating the county machinery. The city will be solely responsible for maintenance and operation expenditures. A commission of five members administers this airport.

Of the seven intercity airports, the Binghamton-Endicott Field in New York is typical, according to the report. In 1936 these two cities passed joint resolutions creating an airport committee and providing for the procurement of the property. Land and construction costs were divided equally. Two members from each of the city councils make up the governing body, which appoints an airport manager. All activities requiring an expenditure of funds must be approved by both city councils. Each city budgets like amounts for maintenance and operation, which are supplemented by airport revenues.

Other intercity airports, like Helena and West Helena, Ark., contribute on the basis of assessed property valuations. The joint airport of Lewiston and Auburn, Me., is financed largely by the state military defense commission. An example of cooperation across state lines is the airport of Pullman, Wash., and Moscow, Idaho.

Two joint projects in Tennessee and two in North Carolina are sponsored by more than two municipalities: The Tri-City airport, constructed, maintained and operated by Johnson City, Kingsport, and Bristol, Tenn., and by Sullivan County, Tenn., is run by an airport commission composed of twelve citizens appointed by the chief officers of the respective municipalities. This joint agency selects the airport manager.

Asphalt Protective Coating For Steel Water Pipes

A. H. Benedict
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***Contents in Brief**—To establish a satisfactory specification for asphaltic coating that can be relied upon to protect steel pipes, The Asphalt Institute made a fundamental analysis and an exhaustive series of tests. The resulting specification is such as can be met by any well-equipped refinery.*

CONFIDENCE in the protection given steel water pipe by asphalt has led to extensive use of a wide variety of asphaltic coatings. Generally speaking, results have justified this confidence; there are cases of satisfactory protection for more than forty years. In many cases, however, serious deterioration has occurred in a short time despite the protective coating. To assure dependable performance, the petroleum industry has been carrying on an extensive research program, through The Asphalt Institute, aimed at the development of a specification for an asphalt enamel which can be relied upon to fulfill all requirements and yet can be produced by any well-equipped refinery. This has now been accomplished and the resultant specification is expected to replace the many heretofore used, including some that were unreliable. In the following are summarized essentials of the extensive study and the resultant findings.

Examining basic causes brought out the fact that two conditions are prerequisite to corrosion: (1) the metal must be in direct contact with its environment and (2) moisture *and oxygen* must be present. Essentially, corrosion is an electrochemical action in which iron goes into solution in the form of ferrous ions carrying positive electrical charges. At the same time, negatively charged hydrogen ions must be plated, or deposited, out of solution, a process which involves flow of electrical current. The hydrogen is deposited as a film of gas on the surface of the pipe; if not removed it will soon prevent further contact between the soil moisture and the metal, thus stopping the corrosive action. For the corrosion to continue, therefore, the gas (hydrogen) must be removed either by mechanical means or by chemical reaction with some corrosive agent such as oxygen. The function of corrosion-preventive coatings is to keep the corrosive agents (more particularly oxygen) from coming in contact with the metal.

Protection must be internal as well as external because the tubercles formed inside the pipe as the product of corrosion not only represent deterioration of the metal but also retard the flow of water.

To be entirely satisfactory, then, a protective coating for steel water pipe must maintain a continuous membrane capable of excluding all corrosive agents. In considering relative merits of various types of bituminous coatings, much attention erroneously has been given to the relative resistance of various products to water absorption. In a thorough investigation of the diffusion of water through bituminous membranes made at California Institute of Technology, the amounts of moisture absorbed during soaking tests were compared with those diffused through normal thicknesses of bituminous films, measured by means of a specially developed, extremely sensitive apparatus. The results of this study clearly indicate that water absorption as indicated by the soaking test is not a measure of the amount of water which will diffuse through a bituminous film and enter into a corrosion reaction with the coated metal.

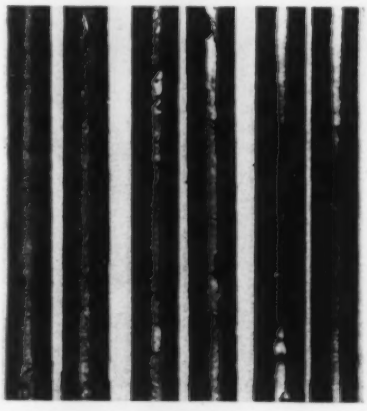

Fig. 1. Three pairs of laboratory samples after being subjected to soil stress tests. Two pairs show coating cracked and distorted, the third is still intact (earth was washed off after the test had been completed)

It was learned that all bituminous materials are pervious to water in approximately the same degree. However, it was also developed that water alone is not sufficient to support an important corrosive reaction. For example, if all the water that could permeate an intact asphalt coating were to react completely and immediately with an iron pipe surface, the resultant corrosive action would require 440 years to eat away a $\frac{1}{16}$-in. thickness of the metal. Moreover, an oxidizing agent would be a prerequisite to such corrosion. Thus it is evident that moisture diffusion alone does not account for the tendency to corrosion.

Supplementing these observations, other investigators found that bituminous materials are much less permeable to oxygen and other gases than to water. The highest oxygen permeability constant thus far reported would require 310 years to get enough oxygen through a $\frac{1}{8}$-in. coating to form the amount of iron oxide (Fe_2O_3) to equal a rust deterioration $\frac{1}{16}$ in. deep. From these data and from studies of the diffusion rates of oxygen and water, it became apparent that in known cases of corrosion the corrosive agent must have found access to the pipe by some means other than diffusion.

Based on these findings more studies were made under conditions simulating those in highly corrosive

PROPERTIES OF FOUR ASPHALT ENAMELS COMPARED WITH RESPECT TO DURABILITY AS PIPE COATINGS

Kind of Test	Enamel A	Enamel B	Enamel C	Enamel D	Asphalt Institute Specification
Softening point (Deg. F.)	256	258	202	248	220 to 260
Penetration (centimeters @ 77 deg. F.)	7	12	17	2	3 to 12
Ash (% by weight)	30.0	30.2	10.2	16.3	10 to 35
High temperature (sagging)	0	0	½ in.	0	⅛ in. maximum
Low temperature (cracking)	No cracking	No cracking	No cracking	Cracked	No cracking
	No disbonding	No disbonding	No disbonding	Disbonded	No disbonding
Peeling	None	None	None	None	None
Impact (disbonded area @ 77 deg. F. in square inches):					
Direct	None	None	None	5	2 (maximum)
Indirect	None	None	None	34	10 (maximum)
Soil stress resistance	No distortion	No distortion	Distorted	Slight distortion	No distortion
Solubility	No discoloration	No discoloration	No discoloration	No discoloration	No discoloration

A and B meet Asphalt Institute specifications; C and D do not.

soils. using metal kept electrically positive to the solution (a condition which tends to accelerate corrosion). After a year of observation such tests failed to show any examples of electrical conductance through or corrosion under even the thinnest coatings (0.01 in.). It was therefore concluded that for all practical purposes diffusion of corrosive agents through an intact coating of asphalt enamel is not sufficient to cause corrosion. Thus the all-important requirement is to *keep the coating continuous under all conditions*, so that there will be no openings of any sort for the free passage of corrosive agents.

Causes of mechanical defects in bituminous coatings were then divided into two classes as follows:

Causes of openings made before the pipe is in service:

1. Bubbles in enamel due to inclusion of air or application of enamel to damp pipe.
2. Contact between porous pipe wrapper and pipe due to excessive tension on wrapper applied over hot enamel.
3. Foreign material in enamel, such as dirt and sticks.
4. Puncture of enamel by contact with hard objects before the enamel has cooled.
5. Cracking of the enamel by vibration during installation of the pipe.
6. Peeling or slipping of the enamel from the pipe due to high temperatures resulting from exposure to the sun.

Causes of openings made after the pipe is in service.

1. Penetration of the coating by hard objects in the pipe trench.
2. Stripping of the coating from the pipe by the action of soil stress. (Poor adhesion, where enamel is applied to pipe which has not been properly prepared, often contributes to this type of failure).
3. Cracking of the enamel due to low temperature.
4. Development of porosity in the coating because of the loss of water-soluble components.

Consideration of the first four causes of defects in coatings is omitted here because their prevention is a shop problem common to all types; rather, attention in these investigations was given to the physical properties of the enamel that enable it to resist the remaining causes of defects. The properties of various bituminous products were compared on the basis of their resistance to the formation of openings or fissures that would permit the passage of corrosive agents. In developing the specifications which have been adopted by The Asphalt Institute, the performance of each product or compound was examined under several tests, notably the six explained in the following:

1. *High Temperature Sag Test*—A coating that failed in this test might flow and so become distorted while the pipe, lying in storage, is exposed to the heat of the sun. This characteristic is a function of both the softening point and the filler content of the enamel.

2. *Low-Temperature Test*—The low-temperature test indicates resistance of a coating to cracking or disbonding during freezing weather.

3. *Peel Test*—This test indicates the ability of a coating to retain its bond to the pipe at temperatures normally encountered. The peel test, combined with the shatter test (explained in the following), exposes improper materials or procedure in prime coating.

4. *Impact Test*—The combined results of direct and indirect impact tests, referred to together as the shatter test, indicate the ability of a coating to resist being shattered or cracked by shocks (1) during transportation of the coated pipe, (2) while lowering it into the trench, or (3) when placing backfill.

5. *Soil Stress Resistance Test*—A clay soil, when drying, can exert a tremendous surface tension on a pipe coating, resulting in serious distortion of many bituminous coatings. This test was designed to ascertain the resistance of enamels to such forces.

6. *Solubility Test*—The solubility test measures the ability of a bituminous coating to retain all of its constituents when soaked in water.

In the accompanying table are listed the results of tests to determine the relative rating of various types of asphalt coatings. The first three tests refer to basic requirements of the material; the remaining six refer to the performance of the coating in service. Only the two enamels, designated "A" and "B," comply with the approved specifications and show entirely satisfactory results in the performance tests.

This table shows that in resistance to vibration or shatter, as indicated by the impact test, the softer enamels (those with the highest penetration at 77 deg. F.) are usually superior to the harder enamels. However, an increase in penetration normally results in an undesirable increase in susceptibility of a coating to penetration by hard objects and to distortion under

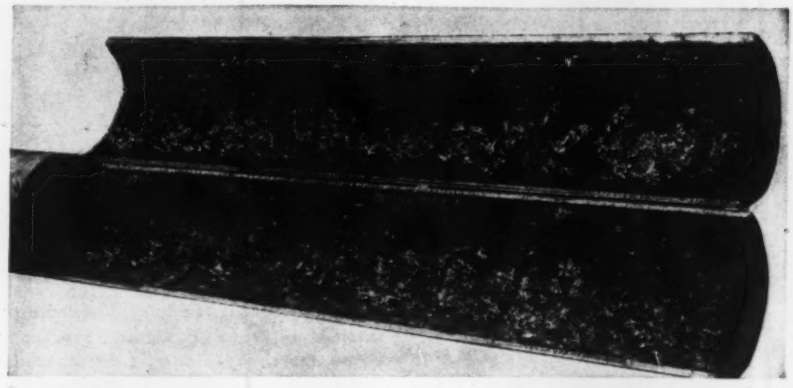

Fig. 2. An example of heavy tuberculation that constricts pipe diameter and decreases flow through a water distribution system.

soil stress. To avoid this type of failure, it is necessary to select an asphalt with an elastic structure which undergoes a minimum change in property with changes in temperature. This type of enamel, while soft enough to resist shatter, is still sufficiently elastic to resist flow and distortion under pressure, as indicated by the soil stress test. It is to be noted that some enamels sufficiently hard to resist the soil stress test are too brittle.

The same elastic structure which enables the best-quality asphaltic enamels to withstand the forces of soil stress, also enables them to withstand the forces set up in cold weather due to differential thermal expansion between steel and enamel, as shown by the low temperature test at —20 deg. F. (Ability to resist flow at high temperatures is indicated by the sag test at 160 deg. F.)

The bond of an enamel to metal depends upon the preparation of the metal surface and proper application of suitable primers. The peel test showed how these conditions were fulfilled in all of the enamels tested.

Summary

After completion of the tests, the following conclusions were drawn:

(1) The wide range in performance of asphaltic pipe coatings results from the wide diversity of products used rather than from any basic deficiency in asphalts as such.

(2) Studies have shown that to cause corrosion both moisture and oxidizing agents must be present. Asphalt enamels are much less permeable to these oxidizing agents than to water. Under microscopically intact films of asphalt enamel, therefore, the rate of corrosion is insignificant.

(3) In known cases of corrosion the corrosive agents have found access to the pipe by means other than diffusion. In both laboratory and field investigations access was found to be by means of openings through the coating caused by defective application or by insufficient strength to withstand the forces encountered in service.

(4) Laboratory tests to ascertain the likelihood of the occurrence of mechanical openings, either during or after installation, showed that enamels that meet The Asphalt Institute's requirements are equal to other bituminous coatings in all respects and superior in several, notably in resistance to shatter at low temperature and to distortion by soil stress. Thus they are highly resistant to the destructive forces encountered in service.

Based on these studies and conclusions The Asphalt Institute's technical committee finally adopted a specification which describes, first, asphaltic materials suitable for priming and for the enamel protective coating to follow. Next, complete specifications are given for application of the primer by brushing and, as an alternate, for preheating and dipping the pipe in a vat of hot primer, as well as for applying the enamel on the inside by spinning the pipe and on the outside by alternate coatings with enamel and wrapping with asphalt-saturated asbestos felt to a maximum of three layers. Finally, detailed instructions are given for performance test procedures to be used in ascertaining the efficacy of the completed protective coating.

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Value of Modern Building Methods Shown by Bombing of England

EXTENSIVE INVESTIGATIONS into the effects of air-raid attacks on reinforced-concrete structures have been carried out by the Department of Scientific and Industrial Research, London. Although it is impossible to lay down hard and fast rules to provide resistance to air attacks with the materials now available in England, certain recommendations have been issued to British builders and architects. These include:

(1) Structural framework and floors should be made monolithic;

(2) Stability of a structure should not depend on a single support;

(3) External columns of a single-story building should be set in from external walls;

(4) External columns of multi-story structures should usually be set in from external walls;

(5) Principal reinforcing bars should be as thick as practicable;

(6) Lap of main reinforcing bars should be increased beyond the normal 24 diameters;

(7) Reinforcement of main beams should be arranged to make such members more capable of carrying their load by cantilever action from the columns;

(8) Some of the bottom reinforcing bars in beams and slabs should be carried beyond the support and into the adjoining spans;

(9) Use stirrups in preference to bent-up bars for resisting shear;

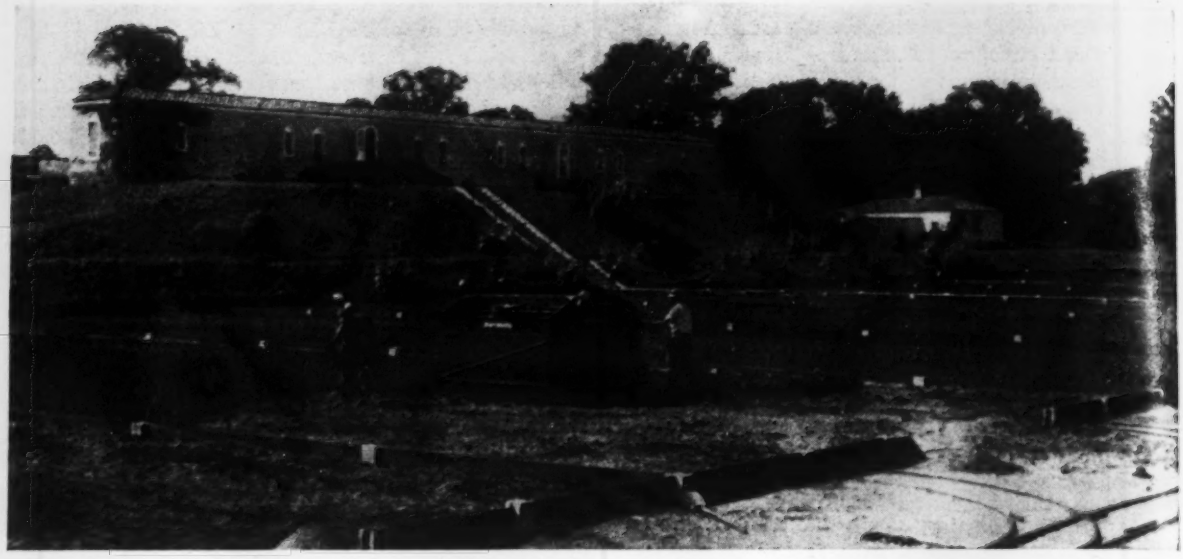
(10) Slab panels should be approximately square and designed as two-way members;

(11) At construction joints transverse slab reinforcing should be provided at the top; and

(12) Slabs should be adequately tied to the beams by stirrups anchored to the top and bottom bars of the beams.

The remarkable manner in which the better designed and newer structures have withstood direct hits from large bombs has resulted in much satisfaction. More extensive failures were noted in cases where both design and construction was of a much lower standard than would be tolerated today, and experience has shown that the heavy loads on the floors and roofs are largely responsible for the damage to the framework. Where the attachment of floor slabs is weak, a slab may become detached from the framework and crash to the next floor below, causing one floor after another to collapse down through the building. In a few cases such extensive damage has resulted. Structures that were only partially framed suffered badly.

Numerous examples of the effect of fire have been noted. In many cases the reinforced-concrete shells of industrial buildings stand, even though the contents of the structures burned. In other cases where an intensive and prolonged fire, greatly weakened the concrete, total collapse has not occurred.



A tractor fitted with sheet-metal "saddlebag" bins removes sludge at Aurora, Ill.

Good Practice in Sludge Disposal

Willem Rudolfs
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New Jersey Agricultural Experiment Station, New Brunswick, N. J.

***Editor's Note**—An aggregation of specialists in sludge disposal, under the leadership of Dr. Rudolfs, related their experiences and recommendations for good practice at the recent Am.Soc.C.E. meeting. Believing that many of our readers would be interested in an expert's analysis of what the experts said, we asked Dr. Rudolfs to prepare this interpretive abstract of the symposium.*

ADEQUATE PREPARATION and proper disposal of sludge continue to be among the principal problems of sewage treatment. It was so recognized at a meeting of the American Society of Civil Engineers in New York, where a symposium on dewatering, drying and incineration of sludge was featured on the program. The following summary of some of the experiences related is designed to highlight those points that may be of broad interest.

Participants in the symposium included: C. E. Keefer, associate engineer, department of public works, Baltimore; W. A. Dundas and C. P. McLaughlin, engineer and assistant engineer of mechanical design, respectively, The Sanitary District of Chicago; George J. Schroepfer, chief engineer, Minneapolis-St. Paul Sanitary District; C. R. Velzy, works superintendent, Buffalo Sewer Authority; Ralph E. Fuhrman, assistant superintendent of sewage treatment, Washington, D. C.; Albert L. Genter, consulting engineer, Baltimore; and LeRoy W. VanKleeck, senior sanitary engineer, Connecticut State Department of Health.

Generally speaking, the processing of sludge for fertilizer or burning requires that the moisture content of primary, digested or activated sludges must be reduced from its initial 92-97 percent to 5 or 10 percent by chemical and mechanical means. Sludge dried on sand beds, whether for ultimate disposal, for fertilizer or for soil improvement uses, must contain the lowest practical moisture content.

Dewatering of sludge on sand beds and by means of vacuum filtration are the only methods extensively used in this country. Sludge pressing with the aid of chemicals is used in a few cases, while preparation for dewatering by cooking or direct dewatering by centrifuge has not been adopted in practice.

In his discussion of dewatering methods Mr. Keefer stated that sand-drying beds will continue to be used to a considerable extent, especially where beds can be used throughout most of the year or where natural sand beds are available. The writer would add that sand beds will be used at many small plants, where considerable land but no technical skill is available and because the method is more economical.

There have been no material innovations in sludge bed drying methods or construction. It was noted, however, that pipes with hot water (heated by digester gas) have been placed under the surface of sand beds to hasten drying, and there has been a revival of the use of alum to cause flotation of the sludge through interaction with carbonates and subsequent production of carbon dioxide gas.

Mr. Keefer emphasized the desir-

ability of letting sludge cake remain on the beds as long as possible to reduce the cost of handling. This requires sufficient drying-bed capacity, which is not always available, so that removal is not always by choice but may be dictated by necessity. Moral: Engineers should provide sufficient drying-bed capacity when designing a plant.

Vacuum filtration experiences

For dewatering by vacuum filtration all speakers appeared to be in accord that:

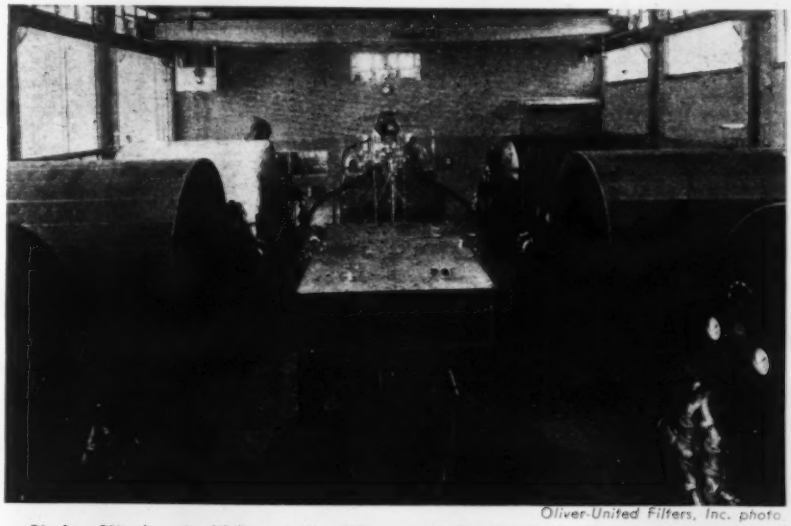
1. Sludge should be concentrated.
2. Operation of filters should be as near continuous as possible.
3. A conditioning agent must be used.
4. The conditioning agents must be added in accurate proportions and thoroughly mixed in a short time.
5. Filtering must proceed as soon as possible after mixing, to take advantage of the floc formed.
6. Flexible machinery and close control is essential.

The type of chemical used for conditioning varies and is usually determined by local conditions, character of sludge, etc. Mr. Genter believes that aluminum and ferric sulfates may be used instead of the chlorides (especially on elutriated sludge), provided proper coagulation is accomplished. Under all conditions its seems that good coagulation is necessary to avoid troubles. In this respect Mr. Genter said that the amount of reagents present in the sludge liquor has a definite influence on the kind and amount of the coagulant used, the kind of floc produced, thickness of filter cake, filter yield, filter cloth life and uniformity of the process. No doubt the type and character of the reagents present also have an important bearing. He listed some 32 factors that are of importance in vacuum filtration, stressing the important relationship of solids compressibility to all principal factors, and he gave clues to further research and possible advances in filtration engineering.

Under the action of gravity or hydraulic pressure the fundamental factors determining filter rates and filter yields depend largely upon the nature of the solids being dewatered, namely, their density, size, structure, surface affinity for water and plastic nature or compressibility under the deforming stresses of gravity or pressure. The conclusion reached by Mr. Genter was that in all dewatering fields employing sedimentation and filtration, difficulties and costs increase with the increasing degree of solids compressibility. The degree of compressibility depends on filtration pressure, whereas compressibility itself is a function or attribute of the nature and structure of the solids—mostly their ability to swell and become plastic. High mineral content and low volatile content of sludge is desirable for economy, and sludge digestion is the best means to obtain this prerequisite.

Measuring efficiency

Of considerable interest were Mr. Schroepfer's findings that the thickness of the filter cake—used as an index for good filtration—is not a measure of efficiency. Contrary to the general belief that thick cakes result in higher efficiency he finds that this mistaken impression has sometimes resulted in the use of higher filter rates, in both design and operation,



Oliver-United Filters, Inc. photo

Sludge-filtering facilities of the Minneapolis-St. Paul sewage disposal plant.

The Dorr Co., Inc. photo

Cyclone separators at the Chicago Southwest sludge incinerator installation.

Nichols Eng'g and Research Corp. photo

Multiple hearth sludge incinerator installation of the Cleveland-Westerly plant. Filters are in the foreground.

than are economical. He backed this up by stating that a filter rate of 2 lb. hr./sq.ft. as compared with a 7-lb. rate cuts operation and maintenance cost in half, resulting in a saving at the Minneapolis-St. Paul plant of some $45,000 a year.

Thorough distribution and mixing of the conditioning chemicals in the shortest possible time was stressed by all speakers. Mr. Keefer definitely favored mechanical mixing; Mr. Schroepfer has improved his air-mixing facilities by increasing the number of points by which air is admitted thus reducing the violence of mixing; Mr. Dundas stated that most devices available, while theoretically correct, fail in practical operation due to their complexity and inability to withstand the corrosive action of the coagulating agent; at Buffalo, said Mr. Velzy, the tendency is to stay away from mechanical appliances for the application of chemicals.

The quantity and type of chemicals used for sludge conditioning varies from place to place. A summary made in 1939–1940 and showing operating data from a number of cities is given in the accompanying table.

Mr. Fuhrman believes that in Washington, D. C., only one-third of the normal ferric chloride is needed on account of elutriation, thus saving an estimated total of $11,000 a year; the cost savings are based on laboratory experimentation, however, and not on plant operation.

The type of filter cloth used is either canton cotton or wool. The life of cloth varies, but seems to come to about 350 to 400 filter hours on the average. Washing with oxalic acid has increased the life of filter cloth at Washington by 30 percent. Difficulties with fungus growths in the cloth (occurring over week-ends when the filters were not operating) which caused complete disintegration of the cloth, have been overcome by applying a 100 ppm. solution of copper sulphate sufficient to saturate the wool. Age of cloth reduces the yield at Minneapolis-St. Paul by 10 to 15 percent; proper washing of cloth is essential to prevent binding and also increases the life of cloth.

Comparing the total operating cost of sand-drying beds with those of conditioning and vacuum filtration, as reported by the various speakers, the writer finds that the range for sand beds is from $.87 to $2.92, with an average of $1.56 per ton of dry solids, as against a range of $2.19 to $8.72 with an average of $4.78 for vacuum filtration.

Drying and incineration

The report by Messrs. Dundas and McLaughlin on heat drying and combustion outlined the factors affecting economical and efficient drying, combustion and fertilizer production. For flash-heat drying, continuous maximum surface exposure of sludge particles (accomplished by mixing with previously dried material and agitation), and the use of superheated water vapor and gases (1,100 deg.) moving at a velocity of 5,000 ft. per min., results in almost instantaneous removal of moisture. The sludge is heated high enough to kill pathogenic bacteria, without affecting its fertilizer properties. Responsive and flexible control is necessary. The temperature of the vapor and gases vented from the drying systems to the furnaces for deodorization is about 350 deg. Operating the system slightly under atmospheric pressure prevents escape of dust and gases.

Since the ignition temperature of carbon-hydrogen compounds lies between 1,100 and 1,200 deg. the authors state that all gases and water vapor must be raised to over 1,300 deg. in the presence of oxygen (air) in order to insure complete, odorless combustion.

Difficulties with drying and burning are less than those met with in dewatering. However, abrasion of flash dryer fans and bend pipes has been severe according to Buffalo's experience. Removal of the preheater at Minneapolis resulted in considerable savings in power. The odor problem has been solved at Chicago with Cottrell precipitators. Use of

gas instead of oil for auxiliary fuel minimized difficulties at Buffalo.

Mr. Schroepfer made the point that while operators of plants employing digestion and drying may complain of the perversity of the bacteria in the digestion tanks, or the unpredictableness of the weather as it affects drying on beds, their problems dwindle into insignificance compared with those of the superintendent of a plant employing complicated and numerous mechanical devices which, even with proper care, display a propensity to break down at the most inopportune time.

The cost of dewatering appears to be from one and one-half to twice the cost of incineration. The total operating cost reported for disposal of sludge varied from $3.53 to $7.69 per ton of dry solids.

Fertilizer production

While incineration, use as fill, and other means of disposal for liquid or partially dewatered sludges have in many cases been the most practical to date, yet, stated Mr. Van Kleeck "failure to use sewage sludge, properly conditioned, as a fertilizer (or soil builder) is an economic waste of a valuable natural resource." Based on the latest information, together with his personal experience, Mr. VanKleeck concluded that some of the larger cities realize and are considering more extended use of sludge as a soil conditioner, that numerous small sewage plants have material available that is certainly worth the cost of hauling, and that sanitary engineers will meet the problems involved in a majority of cases.

Principal objections against the use of sludge as a fertilizer are: Difficulties in making uniform applications, odor, possible presence of pathogenic organisms and the presence of industrial wastes. The value of the material should be judged by the results obtained through its use and not by chemical analysis alone. In addition to the usual soil nutrients the sludge contains so-called trace elements, growth-promoting substances and soil improvement faculties. While digested primary sludge does not have the economic value of raw activated sludge or other special types of sludges, it has a value (based on its principal chemical food constituents, without regard for its valuable humus content) of at least 50 cents per cu.yd. for unground sludge. Difficulties in applications and injurious effects on plants can and are overcome by judicial practice, although a number of problems await investigation.

Unsolved Problems

Some of the problems of sludge dewatering that require study deal with thickness of cake on vacuum filters, type of filter cloth, filter washing to prevent binding and to increase the life of cloth and chemical reactions between coagulants and sludge ingredients, including greases and soaps. There appears to be room for improvement in preheating and heating of the sludge before combustion. Since most of the difficulties occur in the conditioning of the sludge, study on simplified dewatering, sludge concentration with the aid of chemicals or mechanical sludge concentration to a sufficient extent (without chemicals) to allow incineration will lead to improvement, less difficulties and lower costs. In connection with utilization of ash from incinerated sludge and use of sludge for agricultural purposes a considerable amount of experimentation may be conducted to advantage.

OPERATING AND COST DATA RELATING TO SLUDGE CONDITIONING

City	Type of Sludge [1]	Chemical Used	Percent of Dry Cake	Percent of Cake Moisture	Operation costs [2] per ton dry solids
Chicago	P-A	$FeCl_3$	4–7	78–85	$3.10–4.00
Baltimore	D-PA (E)	Chl. copperas	5.04	77.2	3.22
Washington	P (E)	$FeCl_3$	3.18	71.1	4.64
Minn.-St. Paul	P-C	$FeCl_3$ and lime	1.92 4.76	64.7	2.19
Buffalo	D-P	$FeCl_3$ and lime	2.93 11.21	63.1	....
Cleveland Southerly plant	D-PA	$FeCl_3$ and lime	14.2 14.5	72.9	5.70
Cleveland Westerly plant	D-P	$FeCl_3$ and lime	3.6 10.9	65.6	7.51
Muskegon, Mich.	D-P	$FeCl_3$ and lime	3.1 11.2	72.0	8.00
Neenah-Menasha, Wis.	D-P	Lime	3.7	68.0	1.79

[1] P = primary; D = digested; A = activated; C = chemical; E = elutriated.
[2] Including chemical, labor, power, cloth, maintenance.

Corrosive Soil Action Study Develops New Information

Results of the Bureau of Standards exposures of low-alloy steels to corrosive soils indicate that the use of such materials to prevent underground corrosion is only partly effective. On the other hand several experimental nonbituminous protective coatings including a hard rubber, a vitreous enamel, and a baked-on bakelite have been very resistant to corrosive soils for periods of from four to nine years.

Among the coatings tested jointly by the American Petroleum Institute, coating manufacturers, and the National Bureau of Standards over a period of ten years, a thick machine-applied asphalt mastic was outstanding. The tests showed that there was a gradual deterioration of all of the coatings because of holidays, clod pressure, rotting of fabric, or growth of roots, and indicated that a bituminous coating for use in corrosive soils should be thick and reinforced or shielded.

As a result of the studies, bacteria have been added to the list of causes of underground corrosion. However, they are active only in heavy, wet soils low in acidity or alkalinity.

The latest method for determining the corrosivity of a soil is based on the current density-potential curve, i.e. on the current density required to definitely change the potential of the pipe with respect to a reference electrode. The method is still in the development stage.

Cathodic protection as a means of preventing underground corrosion is being extensively used in all parts of the country. Until the use of zinc was restricted zinc anodes increased in popularity as a means of protecting pipes passing through hot spots, i.e. in small areas of corrosive soils.

K. H. Logan is chief of the underground corrosion section of the National Bureau of Standards.

More Power for Bomber Production

***Contents in Brief**—Two dams, both having higher heads than any others east of the Rockies, are being constructed by the Aluminum Company of America to provide added power for the production of aluminum. Both projects are rock and earthfill employing long tunnels and pressure conduits to carry water to downstream powerhouses. Glenville Dam, described here, has the highest head (1,215 ft.) on an impulse wheel in eastern United States. Nantahala project, highest earth and rock dam in the east, will be described in an early issue.*

ELECTRICITY for production of aluminum to be used in the manufacture of bombers is the immediate goal in construction of two high-head earth- and rockfill dams in the mountains of western North Carolina. Known respectively as Glenville and Nantahala Dams, each is higher than any of their type previously constructed in the eastern half of the United States; they attain high head for large power development by use of long pressure tunnels that carry the water from small drainage areas to powerhouses several miles downstream.

The dams are properties of the Aluminum Company of America and are part of Alcoa's privately financed $215,000,000 expansion of facilities for producing and processing aluminum that was started in 1939. Every pound of aluminum produced requires 10 kwh. of power, and as Glenville's annual output is estimated at 120,000,000 kwh. and Nantahala's at 250,000,000 kwh., these new power plants will boost aluminum production by 37,000,000 lb. or enough to build 1,230 "Flying Fortress" bombers.

The two new dams enlarge Alcoa's Little Tennessee River hydro-power system and are located on two of the headwater tributaries. Below them on the main river construction of the great Fontana Dam is just getting underway, while farther downstream are the existing Cheoah and Calderwood Dams. Santeetlah Dam on another tributary also forms part of the system.

Rainfall on the mountains of western North Carolina averages more than 60 in. annually, and runoff is high due to the rocky nature of the terrain and steep slopes. Furthermore, because the land is largely undeveloped and the narrow valleys provide good damsites with large storage areas, the Little Tennessee is generally acknowledged as the best power stream in southeastern U. S.

Alcoa's first hydro development was the Cheoah project, which went into operation in 1919. Cheoah is a concrete gravity-section structure, arched in plan, about 230 ft. high with a 189-ft. head. At the time it was built it was the world's highest overflow dam, its four 24,000-hp. generating units were the largest anywhere, and the transmission line from the dam carried the world's highest voltage (154,000).

Next constructed was Santeetlah Dam on the Cheoah River, completed in 1928. This is a gravity, arched-type concrete structure 205 ft. high

Fig. 1. "Fuse-plug" dams of earth are designed to wash out when overtopped to provide added spillway opening. Note that successive bays are filled higher so that they will fail progressively if water continues to rise.

with useful storage of 131,000 acre-ft. Five miles of pressure tunnel and pipe conduit leads the water to two 33,000-hp. reaction turbines on the shores of the lake above Cheoah Dam. Head developed is 663 ft., the highest in the eastern United States at that time.

Finally, in 1930, Calderwood Dam, an arched-type concrete structure 230 ft. high, was built nine miles below Cheoah Dam thus taking advantage of the storage at the other structures. A short pressure tunnel leads the water to three 56,000-hp. reaction turbines that operate at 214 ft. head.

These three dams supplied much of the power normally used at Alcoa's reduction and fabrication plant near Maryville, Tenn. Through agreements made some time ago with the Tennessee Valley Authority the Alcoa plants were to be supplied with an additional 30,000 kw. of firm power and 30,000 kw. more of secondary power from TVA plants, but later, as the growing seriousness of the war situation indicated that aluminum production would have to be raised to unprecedented levels, the Aluminum Company included the long-contemplated Glenville and Nantahala Dams in its first expansion plans. TVA was able to supply much more than the contract quantities of power but definite shortages could be foreseen throughout the southeast.

First of the jobs to be completed is Glenville on the West Fork of the Tuckaseegee River in western North Carolina. Average rainfall on the drainage area is 80 in. per year and estimated annual runoff above the dam is 94,000 acre-ft. The dam will impound 66,600 acre-ft. of this run-off in a 1,470-acre storage reservoir.

Fig. 2. Glenville dam at an early stage of the earth and rockfill construction. Dark material is the impervious core.

Originally planned as an earth-blanketed rockfill dam, the design was changed to an earthfill dam with rock faces when construction operations revealed a lack of sufficient good rock. The main dam across the river channel is 900 ft. long, has a maximum height of 150 ft. and contains a net volume of 1,060,000 cu. yd. A dam of similar construction closes an adjacent low saddle between hills and contains 233,000 yd.

During construction of the dam, a 9-ft. dia. tunnel 826 ft. long served to carry the stream past the site. It is equipped with two 4x12-ft. gates in tandem for regular or emergency control of the reservoir. This tunnel can be used to completely drain the reservoir if it ever becomes necessary.

Rock for construction of the dam came largely from excavation for a spillway section cut through solid ledge. Material for the impervious core as well as the random fill (Fig. 4) was hauled with carrying scrapers and rolled with tractor-drawn sheepsfoot rollers, all of the equipment assisting in compaction. Shovels loaded blasted rock on heavy trucks for haul to the fill or to the rock-processing plant where material for the courses of sized rock were separate. End-dump wheeled tractors hauled the sized material to place.

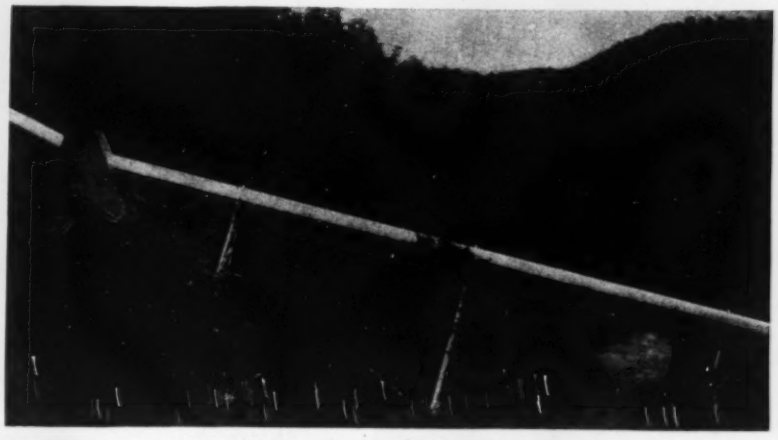


Fig. 3. Between concrete anchor blocks the 8-ft. dia. conduit is carried on double-rocker bents to permit expansion movement.

An unusual spillway

The spillway is a distinct innovation. In addition to two manually operated tainter gates 12 ft. high and 25 ft. long, such as are commonly used for spillway control, the spillway has six "fuse-plug" sections. These latter are small dams of compacted earth protected by riprap against normal erosion, each pair having its top 2, 3 and 4 ft., respectively, above full pool level. They lie across the rock spillway channel between the dam and the tainter gates and are separated into 20-ft. units by the concrete piers carrying the spillway bridge. These dams are designed to fail progressively, if and when overtopped, as the lake level rises due to an abnormal storm. The tainter gates have a discharge capacity of 5,500 cfs. at full-pool level. The capacity of the fuseplugs and

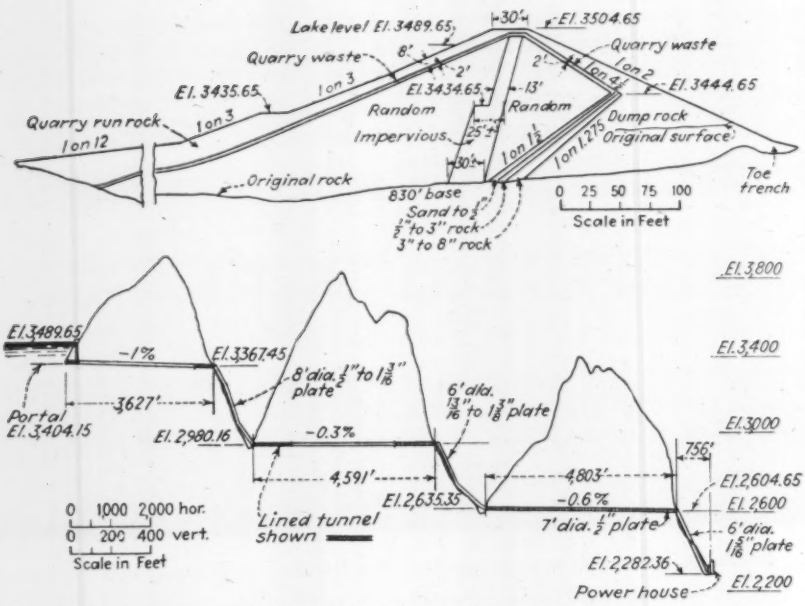


Fig. 4. Waters behind the 150 ft. high dam provide a head of 1,215 ft. at the lower end of three miles of tunnels and pressure conduit. A direct line through three peaks of the Smoky Mountains carries the water to the powerhouse six river-miles downstream. Flood waters continue to follow the old channel.

tainter gates is more than 55,000 cfs. when the water is 10 ft. below the crest of the earth dam. With a 29.4-sq.mi. drainage area this capacity is believed to be adequate for any possible flood. The fuse-plug arrangement provides inexpensive emergency gates as the earthfill can be replaced cheaply if it is ever topped and washed out.

Three miles of pressure conduit

The quantity of water available from the drainage basin and the head available at the dam are relatively small, but the fact that the river has a very large drop in the six miles below the dam made it possible to develop a 1,215 ft. head by driving 13,021 ft. of tunnel and building 3,266 ft. of pressure pipeline to reach a power station site on the river a little over three miles from the dam in a direct line through the mountains.

The intake for water from the reservoir is through a concrete structure with 312 sq.ft. of opening covered by a trashrack of ⅜x2-in. bars with clear openings 1¼ in. wide. Two gates control the opening, one being for emergency use.

Steel lining is used at the portals of the two higher tunnels, the lowest of the three being lined throughout its length. Where the conduit emerges from the tunnel 322 ft. above the powerhouse, it changes to 6-ft. dia. all-welded penstock which descends the mountain side on a steep slope and divides near the powerhouse into two lines that carry water to a double impulse wheel. This penstock line is supported on concrete anchor blocks and by steel bents, unsupported spans ranging up to 81 ft.

Construction of the tunnels started in early September of 1940 and was completed by mid-February 1941, a total of more than 13,000 ft. in a little more than five months. The tunnels were driven from portals, operations being conducted simultaneously at one heading in each tunnel and averaging about 30 ft. per day. About 9 lb. of 40 percent gelatin dynamite was used per yard of rock excavated. The usual advance was about 8 ft. in the two 12-ft. tunnels using 39 or 40 shots to the round. In the 9-ft. tunnel the advance was 7 ft. using 34 or 35 shots to the round. Both detachable and formed bits were used in conventional drifters mounted on a jumbo.

Water at 189 m.p.h.

The power unit is a double impulse turbine, one runner being set on each side of the generator and all mounted on a common shaft. Water is directed under the wheels through a 10-in. needle valve and strikes the buckets at a speed of 277 ft. per sec. using 270 cfs. of water to produce 30,000 hp. at the rated 1,150-ft. head. These runners operate under the highest head on an impulse wheel in the East. The 10-in. jets are said to be the second largest in use anywhere.

The generator is a horizontal-shaft 27,000 kva. three-phase, 60-cycle, machine producing power at 6,600 volts, which is stepped up to 154,000 v. for transmission to the aluminum plants.

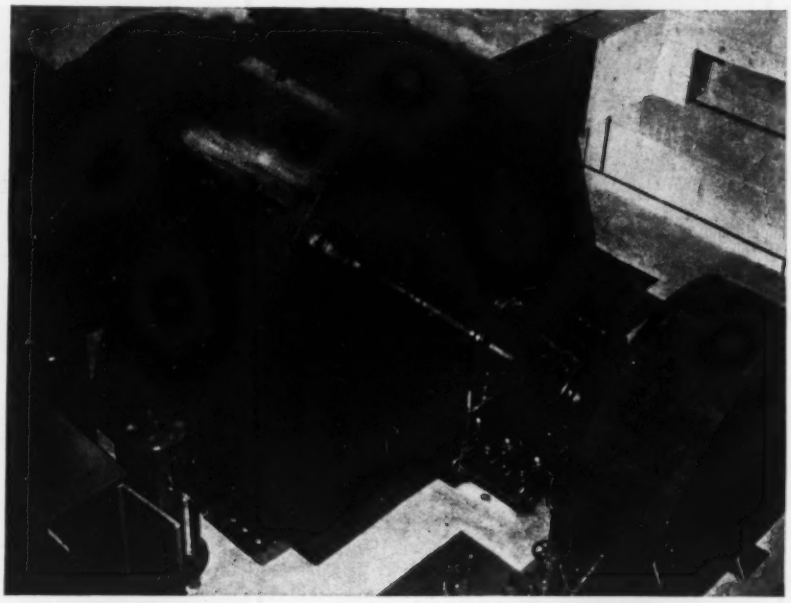


Fig. 5. A double impulse wheel under a head of 1,215 ft. drives the generator in the Glenville power station. The impulse wheels are on the outer ends of the single shaft and the generator is in the center.

This power-producing equipment is located in a concrete frame building, 56x112 ft. in plan and 101 ft. high with its substructure founded on solid rock. Exterior walls are of brick with stone trim. An overhead crane of 115-ton capacity and 50-ft. 6-in. span serves the powerhouse and will handle any of the equipment, including the completely assembled transformers.

Several firms helped

Morrison-Knudsen Co. of Boise, Idaho, built the Glenville dam and powerhouse, drove the tunnels and had overall supervision of the work. C. R. Shinn, vice-president, was in general charge with Gill Griffin, superintendent, H. C. Mervine, assistant superintendent and O. M. Strange, engineer.

The turbine and generator were manufactured and their installation supervised by Allis-Chalmers Manufacturing Co. of Milwaukee. The penstock was supplied by Chicago Bridge and Iron Co. and was installed and welded by the Teleweld Company of Chicago.

For the Aluminum Company of America, James P. Growdon is chief hydraulic engineer and D. J. Bleifuss is principal assistant hydraulic engineer. Lee Greenleaf is resident engineer for the Aluminum Co., succeeding to that position when S. E. Bittner was transferred to nearby Nantahala Dam, the other project of the Aluminum Company.

The completed project was turned over to Alcoa's subsidiary, Nantahala Power & Light Co. for operation under direction of J. E. S. Thorpe who has been the moving force in rush reservoir preparation. Water use will be integrated with the entire Tennessee River system to produce maximum power for defense needs from the installed capacity in the southeast.

A subsequent article will describe construction of the high rock-and-earthfill Nantahala Dam.

Simplifying Concrete Street Construction

***Contents in Brief**—Concrete streets in Mobile, Ala., are built so that the surface has straight slopes at three different angles leading from center line to curb. This eliminates the need for skilled finishers required to form a parabolic crown surface, and the method of construction minimizes longitudinal cracking. A useful kink in curb construction is also described.*

MOBILE HAS ABANDONED the common practice of putting a parabolic crown on its concrete pavements, using instead plain surfaces that are sloped at intervals from center line to gutter. Lack of skilled labor, particularly concrete finishers, was the reason for making the change several years ago when a large paving program was undertaken with WPA labor. The method of construction proved so successful that it is now used for all new streets.

Applying the technique developed by City Engineer Harry L. Fisher, a 22-ft.-wide street pavement is divided transversely from center line to curb line in three parts (Fig. 1) such that a 1-ft.-wide section extends from the curb, followed by two 5-ft. sections. Instead of fitting a parabolic curb to the surface, the forms at each of the three points are lowered an amount equivalent to the ordinate of the parabola at that point, and then the concrete surface is screeded with a straightedge. This produces a transverse road surface from center line to curb with three changes in slope.

"The advantage of this method," points out Mr. Fisher, "is that unskilled labor can shape up the road surface to an exact, uniform slope, with a guarantee that there will be no depressions in which water will collect."

Another advantage of this method of construction arises from the presence of longitudinal joints when the forms are removed; while this separation of adjacent slabs is slight, it is sufficient, nevertheless, to provide for some expansion and contraction and thus minimizes cracking.

One course concrete

Mobile uses concrete exclusively for all new paving because experience in this city has demonstrated its durability and low maintenance cost, according to Mr. Fisher. No reinforcement is used, and the thickness of the slab has been standardized at 5 in., except in heavily trafficked streets, where 6 in. is specified.

A 1:2:3.5 mix has been found satisfactory, and to this is added calcium chloride (dissolved in the mixing water) to aid in curing the concrete. Because the average humidity in this area is 80 percent, sufficient moisture

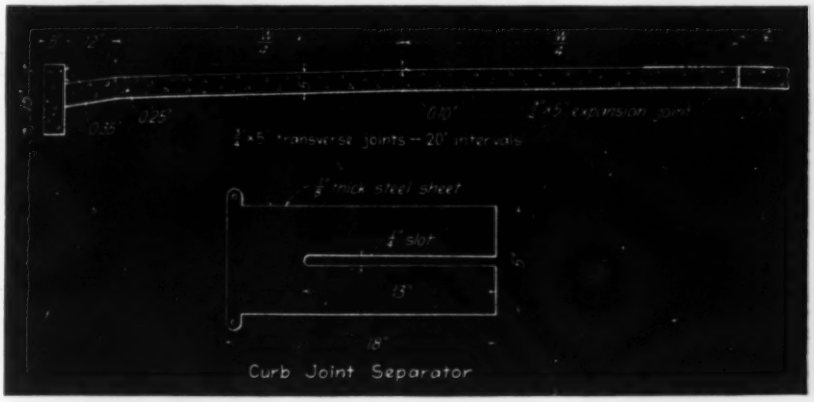


Fig. 1. Typical section for streets 20 to 30 ft. wide; instead of a true parabola-shaped crown, the surface is shaped to fit three planes, each of which is sloped an amount equal to an ordinate of the parabola. The slotted curb joint separators permit the insertion of wire reinforcement between adjacent sections of the curb.

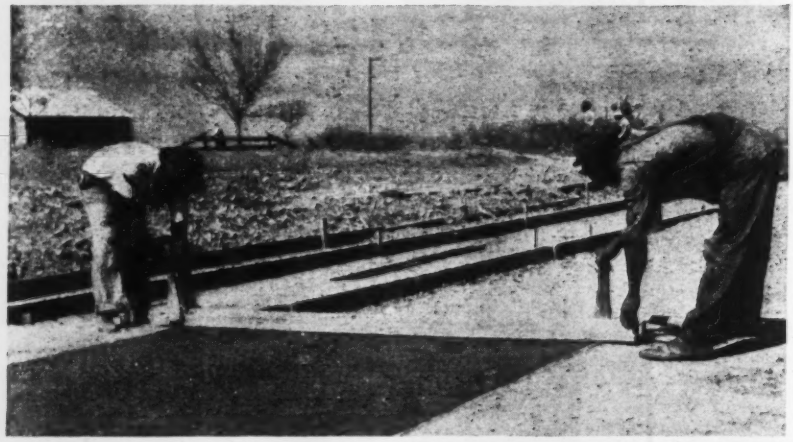


Fig. 2. Step-by-step construction methods: (A) base preparation consists simply of excavation to grade and hand tamping; (B) concrete surface is screeded with an angle-iron-shod screeder; (C) the gutter section is the last to be poured.

is absorbed by the calcium chloride to insure slow drying of the concrete. The calcium chloride additions vary from 1½ to 2 lb. per bag of cement, depending on the temperature and humidity; the larger amount is used in the winter months when the temperature will drop to 30 deg. F. and the humidity averages 60 percent.

The soil in Mobile is a sand loam with enough clay to give it good binding quality. As a result, the base preparation for a concrete pavement consists of little more than excavation to the proper depth and compaction with hand tampers.

Curbs built first

In constructing a pavement, curbs are built first. These are 5 in. wide and 15 in. deep, with the top set at the same elevation as the center line of the street. The gutter is about 4½ in. deep. Curbs are laid in sections 6 ft. long, steel separators being used to provide a construction joint; these separators are oiled so that they can be withdrawn easily when the concrete is set. Details of the curb joint separator are shown in Fig. 1.

An interesting detail of the curb construction is the method used to bind adjacent sections in order that the curb will keep its original alignment. This is accomplished simply by inserting a few loops of No. 10 galvanized iron wire between adjacent sections before the concrete is poured; the steel separator is slotted to accommodate the wire and permit its later withdrawal without disturbing the wire.

Wooden forms for the pavement slabs, which are of 2x6 material, are set to grade after the curbs are in place. Premolded asphaltic expansion joints of ¾-in. thickness are placed longitudinally in the center of the street and also transversely at 20-ft. intervals. Alternate sections of the pavement are poured, and as soon as the section has set up the forms are removed, thus permitting the remaining sections to be poured and finished.

For screeding the concrete a 2x6-in. plank is shod on one edge with a 2-in. angle iron. Fitted with upright handles on each end, this provides a cheap, rigid tool that will give a smooth finish to the surface of the concrete pavement.

The cost of the concrete pavement in Mobile has averaged, during the last few years, $1.70 per sq.yd. laid.

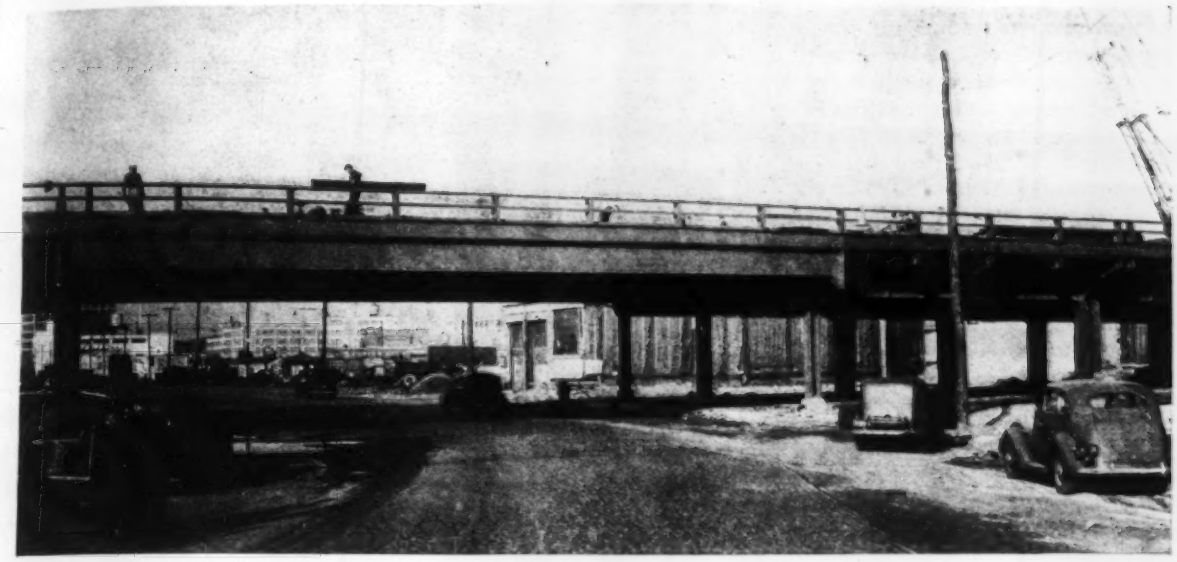


Fig. 1. Composite design greatly reduced depth of construction on Van Dam St. Bridge of Midtown Tunnel approach.

Strengthening Our Highway Bridges

E. L. Pavlo
Chief of Engineering, Madigan-Hyland, New York City

***Contents in Brief**—A novel method of strengthening existing steel highway bridges by integrating a concrete roadway slab with the steel flood system is described. Application of the design is carried out step by step for a typical example.*

INCREASED TRANSPORTATION of goods near manufacturing centers, due to the war program, is imposing greater volume and heavier loads on our existing highway facilities. As the national effort is expected to increase in volume and intensity for some time, the problem of improving our highways to insure an uninterrupted flow of traffic is of timely and great importance. Also, with military traffic and its heavy pieces of modern ordnance and artillery equipment, the ability to maneuver freely without lengthy detours is a primary prerequisite of military tactics. Thus, in a national program of improving our existing highways, the reconstruction and strengthening of weak bridges, which delay traffic and cause detours, may well be considered one of the first objectives.

A Public Roads Administration survey shows that there are approximately 20,000 sub-standard and obsolete bridges on the main routes of the state highway systems. Needless to say, a concerted program for such a vast improvement would entail millions of dollars of expense and in addition is handicapped by the present shortage of steel products. Therefore, in considering various methods of reinforcing and strengthening of existing bridges, economy and ready availability of construction materials acquire special significance.

A description of a novel method of increasing the load capacity of steel bridges follows. The method, which offers considerable advantage from the viewpoint of speed of construction, use of materials, and economy, consists in integrating a new concrete roadway slab with the existing steel of the floor system. This forms a composite tee-beam construction with the concrete of the slab acting in compression and the steel members supporting the slab in tension. The agent combining the two and transmitting the horizontal shear is commonly in a form of a spiral bar, which is welded to the top flanges of stringers or floor beams and embedded in the slab concrete. The strength and the rigidity of the resulting composite section are materially greater than that of the original steel section alone, while the only additional steel materials required are common-size rods, prebent into proper shape. These are field-welded to the existing steel.

Strengthening of existing bridges by creating a composite steel-concrete section is based upon experience with new construction, the composite method having been used successfully during the past few years on new bridges and viaducts in several states. This has been primarily for economy or to obtain a shallow depth of construction to satisfy clearance requirements or a combination of the two. For example, on the Coney Island Bridge (Fig. 2) in Brooklyn, N. Y., built in 1940, the composite design permitted the use of rolled stringer construction for 81-ft. spans designed for an H20 loading and carrying trolley traffic in addition. The composite construction of shallow depth reduced the height and length of the approach walls, effected a considerable saving in cost, and solved a difficult grade-separation problem. Likewise, in the case of the 80-ft. span (Fig. 1) Van Dam St. Bridge, part of the approach viaduct to the Queens-Midtown Tun-

nel under the East River at New York, the street clearance requirements limiting the available depth of construction were economically fulfilled by the use of composite construction. In both examples the greater rigidity and strength of composite construction extended the use of rolled beams for the spans of unusual length heretofore reserved for built-up girders.

The principles involved and the design procedure with the composite construction method are now to be illustrated step by step for strengthening a three-span highway crossing built in 1932 for an H15 loading. A cross-section of the bridge is shown by Fig. 3. The bridge's superstructure, consisting of 21-in., 64-lb. longitudinal beams on 3-ft. centers, supports a 6-in. strip timber floor with a 4-in. wearing course. The spans are 40 ft. and the bridge is to be strengthened to carry H20 or H20-S16 loading in accordance with the 1941 American Association of State Highway Officials standard specifications.

Design procedure

The insufficient timber deck is replaced by a 6-in. thick reinforced-concrete slab. Near the center of the span the slab thickness is made an extra $\frac{1}{4}$ in. thick to compensate for the increased dead-load deflection. The resulting tee section is shown in Fig. 4. The neutral axis of the new section is located by equating the statical moment of the compression area to that of the transformed tension area, using $n = 10$. With x equal to the distance from the top of the slab to the neutral axis, the value of x is given by the relation $(x - 3.125) \times (36) \times (6.25) = (16.813 - x) \times (18.82) \times (10)$ or $x = 9.36$ in.

The transformed section's moment of inertia is

$36\ (9.36^3 - 3.11^3) \div 3$	=	9,480 in.^{4}
$1403.3\ (10)$	=	14,033 "
$18.82\ (10)\ (7.453^2)$	=	10,440 "
		33,953 in.^{4}

For calculating the dead-load moment, use a weight of 66 lb. per lin. ft. of girder as the weight of the stringer and spiral reinforcing. This makes the total dead load 301 lb. per lin. ft., since the weight of the slab per ft. of stringer equals $\frac{6.25}{12}$ (150) (3) = 235 lb.

Thus, the dead-load moment is

$$M_d = \frac{0.301 \times 40^2}{8} = 60.2 \text{ ft.-kips}$$

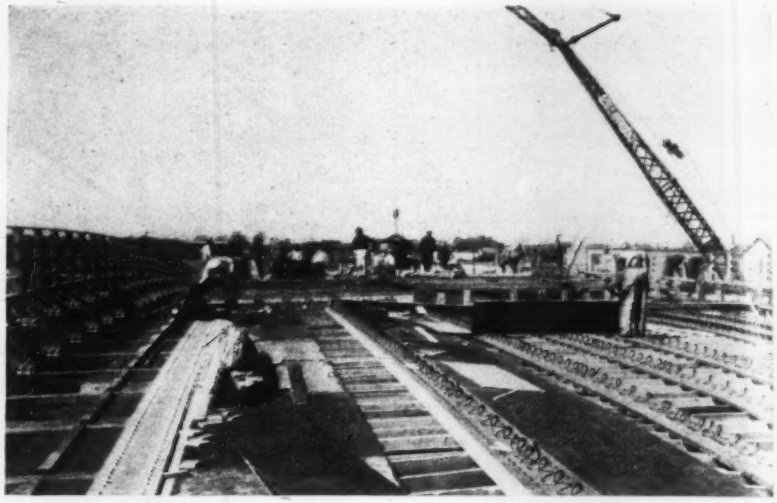


Fig. 2. Reinforcing spirals are welded to stringers of the superstructure. Work shown was part of Coney Island project where composite method solved difficult grade-separation problem.

For the live-load moment, using an H-20 loading (Fig. 5), the fraction of wheel load per stringer (Item 3.3.1 of spec.) is $\frac{S}{5} = \frac{3}{5} = 0.6$, while the impact $= \frac{50}{125 + 40} = 30$ percent (maximum). The live-load moment is then $M_L = \frac{20 \times 18.6^2}{40} \times 1.3\ (0.6) = 135$ ft.-kips.

In figuring unit stresses for the H20 loading, assume the dead load is sustained by the stringers alone, unless they are restrained from deflecting by a temporary support while the slab is being constructed. Thus, the stress in the stringers due to dead load is $f_d = \frac{60{,}200\ \ (12)}{132.85} = 5{,}440$ psi. The stress in the stringer due to live load is f_{tl}

$$= \frac{135{,}000\ (12)\ (18.016)\ (10)}{33{,}950} = 8{,}600 \text{ psi.}$$

$$f_{cl} = \frac{135{,}000\ (12)\ (3.11)\ (10)}{33{,}950} = 1{,}485 \text{ psi.}$$

Maximum stress in the stringers is then 5,440 plus 8,600 or 14,040 psi. tension.

Maximum stress in the concrete is

$$f_c = \frac{135{,}000 \times 12 \times 9.36}{33{,}950} = 448 \text{ psi.}$$

Thus, both steel and concrete stresses are below the allowable. Since the existing stringers were designed for 16,000 psi. stress, the composite section is capable of carrying 16,000 − 5,440 = 10,560 psi. stress due to live load. The maximum live load that the composite section is good for is therefore

$$\text{H20} \times \frac{10{,}560}{8{,}600} = \text{H24.6}$$

This represents $\left(\frac{24.6 - 15}{15}\right) 100$ or 64 percent increase in the load capacity of the bridge.

In calculating unit stresses for the H20-S16 loading (Fig. 5) $M_l = \left(\frac{36 \times 17.67^2}{40} - 4 \times 14\right) \times (1.3)\ (0.6) = 176$ ft.-kips.

Increasing the stresses by the ratio of 176 to 135 makes $f_c = 583$ psi. and $f_{tl} = 11.200$ psi, while f_d remains 5,440 psi. Thus, the total stress in the steel is now equal to

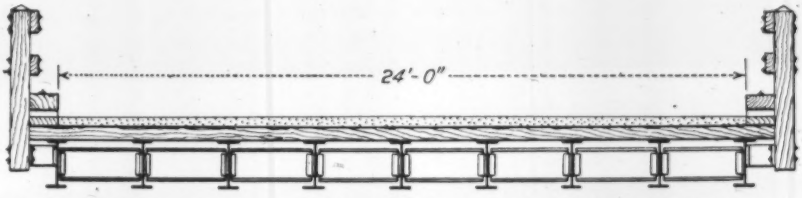


Fig. 3. Cross-section of a 3-span highway bridge built in 1932 for H15 loading. This is crossing for which step-by-step application of strengthening method is illustrated.

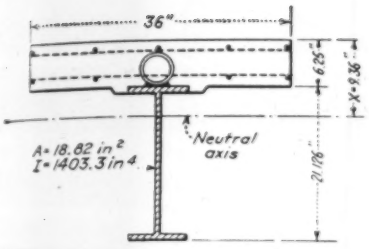


Fig. 4. For strengthening bridge illustrated in Fig. 3 wood deck is replaced by 6-in. thick reinforced-concrete slab, which is made integral with existing steel frame by means of reinforcing spirals welded to the stringers.

11,200 plus 5,440 or 16,640 psi. tension.

In determining the maximum live-load deflection use $d = \frac{ML^2}{12EI}$ or

$$d = \frac{176 \times 40^2 \times 10 \times 1728}{12 \times 29{,}000 \times 33{,}950} = 0.412 \text{ in.}$$

The deflection ratio is then $\frac{0.412}{40 \times 12}$ or 1 in 1,166. This deflection for the H20-S16 loading compares with a 0.69-in., live-load deflection of the existing bridge for the H15 loading.

Design of spiral steel

The function of the spiral steel is to bond the slab to the stringers and to transmit the horizontal shear. The design procedure is analogous to the determination of size and pitch of rivets in riveted-girder construction. The increment of horizontal shear per unit length is expressed by the relation $\frac{VQ}{I}$ where V is the vertical shear, Q the static moment of the concrete section, and I the moment of inertia of the whole transformed section.

To obtain maximum shear, consider the span loaded as in Fig. 6.

$$\text{then } R_1 = 1.3\left(16 + 16 \times 0.6 \times \frac{26}{40} + 4 \times 0.6\frac{12}{40}\right) + 0.3 \times 20 = 35.8 \text{ kips}$$

That the dead-load shear is included in the calculations of the shear reinforcement will be noted. This inclusion is advisable and is on the safe side.

Maximum shear at the center of the span equals

$$\left(0.5 \times 16 + 16 \times \frac{6}{40}\right) \times 0.6 \times 1.3 = 8.1 \text{ kips}$$

The horizontal shear is then

$$\frac{Q}{I} = \frac{36 \times 6.25 \times (9.36 - 3.125)}{33{,}953}$$

$= 0.041$. Thus $\frac{VQ}{I}$ at the support equals 0.041×35.8 or 1.47 kips per inch; that of the quarter points 0.041×21.95 or 0.90 kips per inch, and that at midspan, 0.041×8.1 or 0.33 kips per inch. For any selected size of spiral, the welds must be of sufficient strength and number to transmit the aboye shear.

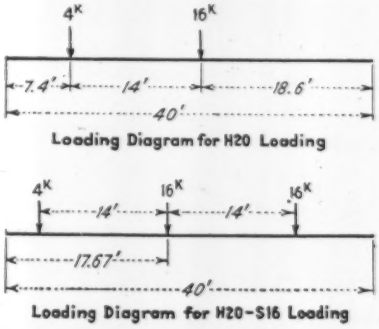


Fig. 5. Loading diagrams for maximum live-load moments with H20 and H20-S16 loadings.

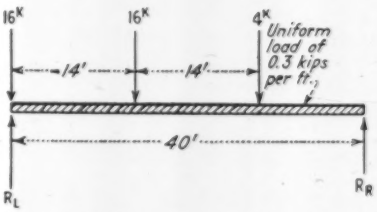


Fig. 6. Loading diagram for maximum live-load shear with H20-S16 loading.

Assume that a spiral of 4-in. mean diameter and made of ½-in. round rod is used. The allowable stress on rod is 0.196×16 or 3.14 kips. Since the spiral on one side of the weld is in compression and on the other in tension, the weld must withstand a total load of 2×3.14 or 6.28 kips. A $\frac{5}{16}$-in. fillet weld $1\frac{1}{4}$ in. long on both sides of the spiral will meet this requirement. The spacing of welds or the pitch of the spiral near the support must, therefore, be no more than $\frac{6.28}{1.47}$ or 4 in., that at the quarter-points no more than $\frac{6.28}{0.9}$ or 7 in., and at the span's center $\frac{6.28}{0.33}$ or 19 in. The pitch of the spiral can, therefore, be increased toward the center of the beam in accordance with the diagram shown in Fig. 7, or the size of the spiral and the welds can be made variable. A working arrangement for the spiral layout is as shown in Fig. 8.

The developed length of the spiral rod and the rod's weight can be estimated by the formula $L = \frac{12}{s}\sqrt{(\pi d)^2 + s^2}$, where L is the developed length of the spiral per foot of beam, d the mean diameter of the spiral and s is the pitch, all dimensions being in inches. In estimating the length an extra 6 in. should be added at the splices.

Cost of strengthening

Using the above formula, the developed length of spiral per beam amounts to 111.5 ft. while the weight of spiral per beam is 111.5 × 0.668 or 74.5 lb. The number of welds per beam is 93 and the length of welding per beam is $93 \times 1\frac{1}{4} \times 2$ or 232.5 in. Thus, the total weight of the spiral for all the bridge is 74.5×9 or 670 lb., and the total length of welding is $232.5 \times 9 \div 12$ or 174.6 ft. Estimating the cost of spirals at 14c. a pound and that of field welding at 75c. per lin. ft., the total cost of strengthening for one span amounts to $224.80 or 23.5c. per sq.ft. of roadway. The cost of concrete slab is not included in the above estimate, since the existing timber deck had to be replaced irrespective of the method of strengthening the steel superstructure.

Thus, at very little cost the bridge's capacity is increased by 64 percent and the rigidity by 140 percent. The

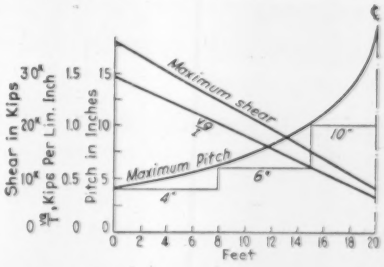


Fig. 7. Diagram for calculating maximum shear, $\frac{VQ}{I}$, and pitch of spiral reinforcing for H20 loading.

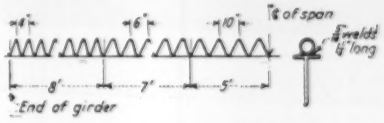


Fig. 8. Spiral layout as found satisfactory for strengthening bridge illustrated in Fig. 3.

live-load deflection of the strengthened bridge for an H-20-S16 loading is 40 percent less than the live-load deflection of the old bridge for an H15 loading. This load capacity increase, though sizeable, is comparatively small due to close spacing of the stringers. With a wider and more common spacing of the stringers, the load capacity can be increased considerably more. In special cases it may be found expedient to increase the strength of the composite section by welding a cover plate to the lower flange of the existing beams.

The method described is equally applicable to strengthening bridges of built-up girders and floorbeams.

How To Double Sewage Filter Capacity

***Contents in Brief**—Alternating double filtration is the term applied to a new method of operating trickling filters, which has been developed in Great Britain. The following description of the method is taken from a report appearing in the Dec. 12 issue of* The Surveyor, *London.*

SOME YEARS AGO the Water Pollution Research Board in Great Britain was faced with the problem of devising a satisfactory method of purifying the waste washwater from milk collecting depots and from the manufacture of cheese, butter, and other milk products. Among the methods tried was that of treatment by single filtration according to the process ordinarily employed for domestic sewage. Satisfactory purification was obtained for a time, but the quantity of solid matter, including growths of fungi and other organisms, which formed in the top layers of the filter soon clogged the filter.

Experiments in the laboratories of the Birmingham, Tame and Rea District Drainage Board, revealed that excessive quantities of solid matter, which had accumulated in the top layer of the filter as a result of supplying the filter with milk effluents, could be removed and the filter again brought into a satisfactory condition if the filter were treated for a week or two with purified effluent from another filter.

This observation led to laboratory experiments in which the milk effluents were passed first through one trickling filter and then through a second trickling filter. After the filters had been in operation for about two weeks, the milk effluents were supplied during the next two weeks to the second filter and the treated liquid from this filter was passed through the first filter. The order of the two filters in series was changed at intervals throughout the experiment. The laboratory experiments showed that by this new process of alternating double filtration the difficulties previously caused in single filtration by excessive accumulation of solid matter were avoided.

On the basis of these findings a large experimental plant was installed at a cheese factory and operated under various conditions for three years without any serious difficulty. Throughout this period final effluents of excellent quality were obtained; in fact, the quality of the effluent was so good that trout were able to live in it for long periods without suffering any harm. While these experiments were in progress full-scale plants were erected at several milk depots and these plants have been in satisfactory operation for several years.

In addition to the observation that this new process of alternating double filtration satisfactorily purified milk effluents without difficulty, it was discovered that the quantity of organic matter removed for each cu.yd. of filtering medium was about twice as much as the organic matter removed in the treatment of domestic sewage by the normal process of single filtration. It was decided, therefore, to carry out experiments on a large scale on the same process of alternating double filtration in the treatment of domestic sewage.

Four large trickling filters, each containing about 2,300 cu.yd. of filtering medium, were placed at the disposal of the Water Pollution Research Board and experiments have now been in progress for more than three years. One of the large filters has been operated by the normal process of single filtration and two have been operated by the process of alternating double filtration, using sewage liquor from the same source. It has now definitely been established that by the new process the quantity of sewage liquor which can be efficiently purified by alternating double filtration is twice as great per cu.yd. of filtering medium as that which can be efficiently purified by single filtration.

This result at once shows how the capacity of existing trickling filters at sewage disposal works can be doubled. In changing over from the old process to the new process it is necessary to install additional tanks to remove solid matter from the effluent from the primary filter before this liquor is supplied to the secondary filter. It is also necessary to install pumps to pump the settled liquid from one filter to the other filter. The net overall saving in capital cost and in materials of construction, however, is considerable, and with sewage works of medium or large size the saving in capital charges is much greater than the additional cost of pumping.

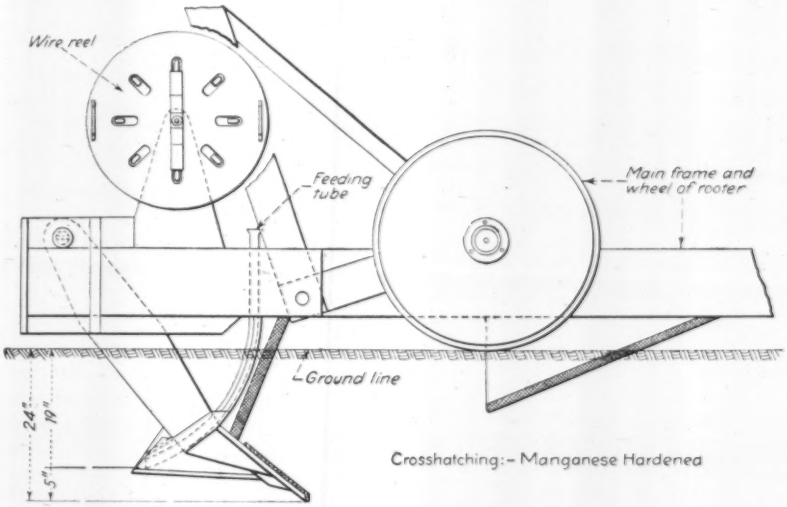
The new process has already been applied in several sewage treatment plants with appreciable savings in cost and in materials of construction. The change in the order of the two filters in series in the treatment of sewage is usually made at intervals of one week.

At the present time the two large experimental filters employed for the treatment of sewage liquor by alternating double filtration are efficiently treating per cu.yd. of medium about three times the quantity of sewage which can be treated by single filtration. This very high rate of treatment has only been in operation for a few months. Further experience is required to determine definitely whether this high rate can be maintained continuously, particularly during the cold winter months when biological activity is lower than during warm summer months.

Tractor Drawn Rooter Plows Wire Into Soft Rock

Robert C. Dean
Electrical and Mechanical Engineer
Hoosier Ordnance Plant, Charlestown, Ind.

About Seventy Miles of size No. 1/0 and No. 4 bare copper wire was plowed about 22 in. into the earth as a grounding network or grid at the Hoosier Ordnance plant near Charlestown, Ind. Underlying rock formations and ledges indicated that it would be difficult digging for an ordinary wire-laying plow so a special wire layer was built at the job from an available heavy-duty rooter. Three to four miles of ground wire were laid per day through varying materials, including gravel, shattered rock formation and piles of stone.



Details of wire laying device showing its installation on a heavy duty rooter.

Several positive grounding connections were required on all buildings in which powder is handled or stored for protection against static, lightning and inductive current. Ordinary ground rods or plates were unsatisfactory because of a continuous underlying limestone formation.

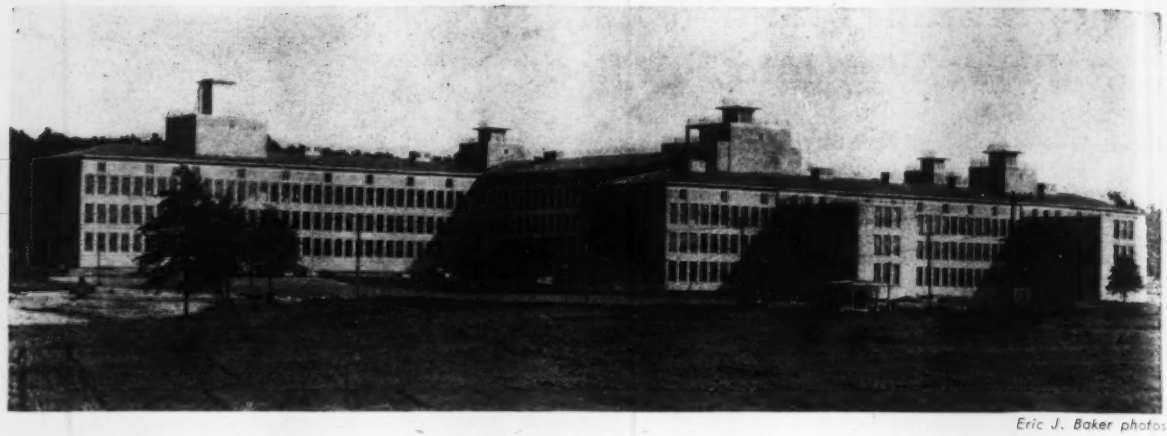
The two outside teeth of the rooter were removed from the machine and the middle tooth rebuilt to deposit wire underground. A smooth, grounding tube was attached to the rooter and carried through the tooth to the back of the plow blade at the required depth below the ground. A payout reel, constructed to carry the coils of ground wire, was mounted on top of the frame. A sod cutter was found necessary to prevent the accumulation of sod around the rooter teeth and was installed under the frame bar as shown in the accompanying drawing. All cutting edges were hardened by application of manganese facing. Because all connections were copper-welded or brazed, the feeding tube was made large enough to permit the welded splice at a new coil connection to pass through and be buried without raising the rooter tooth.

The wire layer was used to place the 60-to 75-ft. lead lengths of wire exposed at the building and attached to the reinforcement, structural steel, static collectors, hardware grounds and lightning arresters. Laying was accomplished by backing the machine up to the point where the wire emerged from the building and threading the lead length in reverse through the feeding tube, the full length being pulled through this tube. With the rooter tooth lowered into the earth, the converted machine was used to bury this lead length of wire up to the point where it joined the grounding grid system lead.

Cutting edge and wire laying tube.

The work was one under the supervision of Lt. Col. R. E. Hardy, constructing quartermaster, at the Hoosier Ordnance Plant. Contractors on the work were a combination composed of Winston Bros. Co., C. F. Haglin & Sons, Inc., The Missouri Valley Bridge & Iron Co. and Sollitt Construction Co., Inc.

Tractor-drawn heavy-duty rooter digs through rock formation to lay wire 22 in. underground at the Hoosier Ordnance plant.



Eric J. Baker photos

Fig. 1. The new Bell Telephone Laboratory, which will accommodate 800 research technicians.

A Research Laboratories Building

***Contents in Brief**—To meet the requirements for special physical and chemical research facilities, a new $3,000,000 building of very unusual design is rapidly being completed at Murray Hill, N. J. Layout is such that any of 15 different services are available at any laboratory bench or can easily be made so. Noteworthy is the arrangement for dividing each floor into small individual laboratories, a group of larger units, or a laboratory covering an entire floor. Construction was begun only after two years of experimental work to determine the best possible design, piping layout, electric power distribution and manner of altering the size of the individual laboratories.*

NEARING COMPLETION at Murray Hill, N. J., is a three-story plus attic-and-cellar building designed especially to meet the requirements of 800 workers engaged in physical and chemical research and engineering development for Bell Telephone Laboratories, Inc. An unusual design was necessary to provide for quick rearrangement of the laboratory areas and for present or systematic future installation of any of the fifteen different services at all laboratory benches. These services include: illuminating gas; air at 60-lb. pressure; vacuum; oxygen; nitrogen; hydrogen; steam at pressures of 5, 50, and 125 lb.; telephone service; hot, cold, chilled and distilled water; and 208-v., 3-phase and 120-v. single-phase alternating current. To make all these services available and to provide adequate waste disposal facilities called for a special building. The piping arrangement had also to allow for possible future installation of other services. In addition, lighting conditions had to be good and the chemical laboratory ventilation system of the best, because of the work to be done in some areas.

To meet all these requirements, long before the design of the building was started, numerous laboratories were visited and investigations made to determine the most satisfactory building type. Questions to be answered included: (1) Maximum practical depth from windows; (2) size and spacing of windows; (3) floor loads to be supported; (4) ceiling height required; (5) units of laboratory equipment most generally used; (6) size standardization of these units; (7) services required and their distribution; (8) floor layout most suitable for laboratory and office purposes; and (9) most satisfactory method of subdividing the laboratory space into separate rooms.

The answer to some of the questions showed two different room depths—27 and 19 ft.—as being satisfactory. The 27-ft. dimension was selected as about the maximum distance at which good daylighting could be expected, while the 19-ft. dimension was selected as affording a suitable depth for small laboratories and offices. For the spacing of the windows and the unit dimension parallel to the outside walls, a distance of 6 ft. was considered best. To make each unit of floor area complete with all essential services was also deemed best. Meeting these requirements was possible by using one row of interior columns down the center of each floor, locating a 6-ft. wide corridor to one side of these columns and spacing the windows, floor beams, lighting and other fixtures on 6-ft. centers.

Test house built

However, to test what was considered the most satisfactory layout, especially that of providing all the various services required, a full-scale model of a typical proposed floor unit was built as soon as the building's fundamental dimensions had been fixed. This model building, known as the test house, reproduced the exact arrangement that was planned for five basic floor units, namely, a space 30 ft. wide and 27 ft. long. A corresponding cellar space underneath was also provided. Thus, it was possible to study conditions at the outside walls, at the center columns, and in the cellar of those points considered the most critical locations as far as service distribution was concerned.

Many schemes were proposed and tested for providing each unit of floor area with any service at minimum

cost and least disturbance to surrounding areas. The test work saved much time and money once construction operations were begun, since service interferences were discovered and eliminated; workable spacings for pipes and fittings were established; the most satisfactory types of fittings, hangers and fixtures were determined; and the entire scheme of service distribution greatly improved and simplified.

The piping plan adopted calls for the installations of the service mains either in the basement or attic. Risers are grouped at the outside walls on 6-ft. centers but with the risers for any one service appearing only once in four groups, or on 24-ft. centers. The exception is the heating and drain risers, which appear in alternate groups. This plan required that the building's final design would make possible: (1) horizontal runouts below the window sills and behind metal wainscoting on each floor, and (2) extension at 6-ft. intervals of all services into the working area. Details of this plan are given later.

The $3,000,000 H-shaped structure built (Fig. 1) is a small portion of the ultimate development on the site. The structure provides for 250,000 sq.ft. of gross space with 85 percent of the area actually available for use. Each section of the building has three main floors, cellar and attic. Although the building is designed as a walk-up structure, elevators are being installed for moving materials and equipment, and for limited passenger use. The building has a steel frame, reinforced-concrete floors, 4-ft. wide steel sash windows, and brick walls with limestone trim. The longer of the two parallel sections is 670 ft. in length, the shorter about half that long, and the connecting section is 144 ft. long, forming an adequate court between the two parallel units.

All main sections of the building are 54 ft. wide overall and the height from floor to floor is $12\frac{2}{3}$ ft., which gives a clear ceiling height of $10\frac{2}{3}$ ft. from floor to beam soffit on all floors. In order to get uniformity of space, the basic dimensions of all sections are the same, that is, on all floors the window and column spacing, ceiling height, and the depth of space from the outside wall to the corridor is the same.

Projecting at intervals of 168 ft. from the main sections are wings about 50 ft. long by 38 ft. wide. These are for offices only and are designed for subdivision into 8x14-ft. areas.

Unusual steel framework

In order to meet the requirements of uniform ceiling throughout, to provide windows on 6-ft. centers, and to permit access to the cellar and attic services at intervals of 6 ft., it was necessary to depart somewhat from orthodox practices in designing the building's steel frame. First, in order to avoid a deep floor girder down the center of all sections of the building, two 16-in. deep longitudinal steel girders are used, one on either side of the single row of center columns, which are on 24-ft. centers. These columns are 18-in., 85-lb. H-sections on the lower floors, reducing to 65 lb. for the top floor. The longitudinal girders have the same depth as the floorbeams, so that the height from floor level to the fireproofing around the floorbeams and girders is the same. The 18-in. wide space between the double girders at the center columns provides space for vertical chases for ventilating flues and vertical distribution of unusual services.

Another major difference from an orthodox design is the arrangement of the exterior columns. Instead of large columns on the 24-ft. spacing of the interior columns a series of steel struts on 6-ft. centers is used. Each strut consists of two 4x3½x⅝-in. bulb angles side by side with the longer leg pointing outward. The two angles are bolted together with spacers between slightly wider than the web of the 16-in., 50-lb. floorbeams, which are also on 6-ft. centers; by cutting away the floorbeam flanges at their outer ends the web could be inserted between the bulb angles for a bolted connection.

In order to make available sufficient space for the service risers within the 2-ft. wide area between windows, still more or about another foot of the floorbeam flanges had to be cut away at the outside walls. In this way two 9x12-in. openings were formed, to make possible a vertical chase on either side of the floor beams.

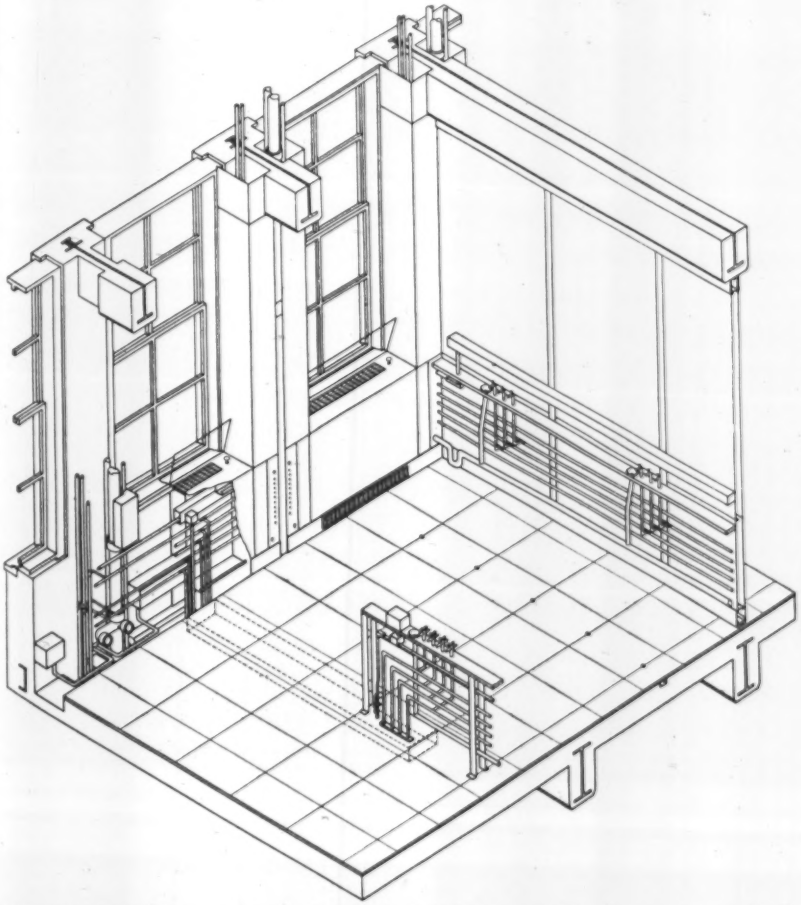


Fig. 2. Details of an exterior wall and a subdividing partition showing the method of providing the many services required.

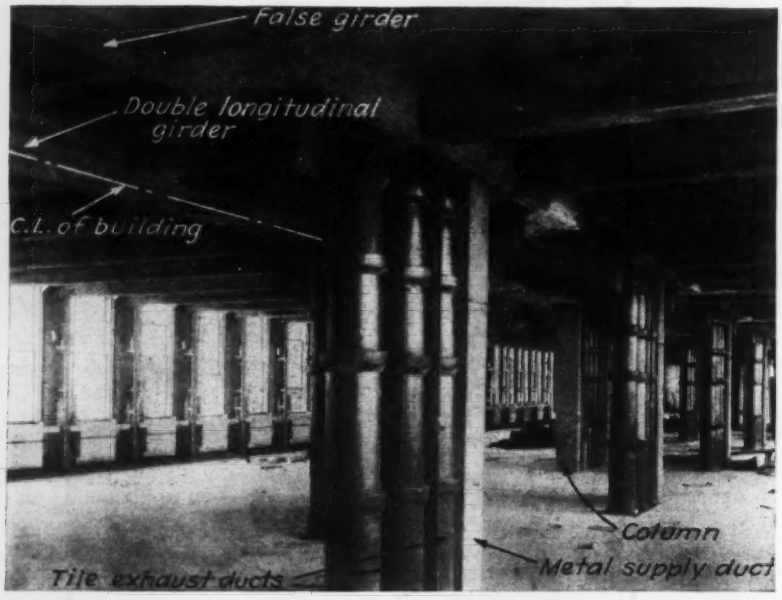


Fig. 3. Along the center line of the building double girders are used with the depth the same as the floorbeams. Walls of the corridor, which will run between the two lines of ducts, will be constructed with 4-ft. wide panels of the type employed for transverse partitions. Note how exhaust ducts are made of tile to withstand the fumes that may be developed in some areas.

Designed for a live load of 150 lb. per sq.ft., floors in the laboratory areas consist of a 4-in. thick reinforced base of light-weight concrete made possible by an admixture of aluminum oxide. Above this is used a 4-in. fill of relatively weak and still more lightweight material and then a 1-in. concrete finish. In addition, for the chemical laboratory floors a $\frac{1}{8}$-in. asphalt surfacing is planned, while in the physical laboratories a $\frac{1}{8}$-in. linoleum is to be used. The reason for the deep fill is to provide space between the structural slab and the finish layer for service lines and ducts, although most services are carried above floor level.

The ducts in the floor are of two types. A standard $1\frac{1}{8}$x3-in. metal duct with outlets every 2 ft. is used for underfloor distribution of telephone or laboratory electric power circuits. These ducts extend outward from the exterior walls on the centerline of every window. For mechanical services at island bench locations in the chemical laboratories a 4x12-in. metal trough 8 ft. long is used with a metal cover flush with the finished floor but covered by the asphalt or linoleum. Service pipes come out of this trough through a slot in a specially designed cover section. This prevents liquids accidentally spilled on the floor from running into the trough.

For the exterior walls a 2x4x11$\frac{3}{8}$-in. brick is combined with sand-lime backup brick, which permitted convenient construction around the many 4-ft. wide windows. In the laboratory areas the windows are 9 ft. high and, to aid ventilation, the tops are made flush with the ceiling. To cover the vertical risers and horizontal service runouts a 20-gage metal wainscoting is used for the full width below all windows and to complete enclosure of the two vertical chasses at each exterior column. This wainscoting is so constructed and the horizontal runouts so arranged that access to any of the services below the windows is possible every 6 ft. by removal of a small section of wainscoting (Fig. 2). For removal of the wainscoting, only a screwdriver is necessary, and in less than five minutes one man can provide access to any or all of the services available. Extension of the services from the exterior walls is accomplished by piping attached to the subdividing panels or by piping in the floor fill (Fig. 2).

Subdivision of the floors

One of the most significant features of the building is the subdivision of floor areas by metal panels 4 ft. wide and 10$\frac{2}{3}$ ft. high, or the full dimension from floor level to the lower edge of floorbeams and girders. Each panel is 3 in. thick and consists of two layers of 20-gage metal separated by rock wool, which makes the panels very fire resistant and satisfactory as to sound transmission. The corridor walls are also made of the subdivision panels, which are interchangeable with panels equipped with doors and transoms where these are needed. The owners believe they have found a very satisfactory method of quickly and conveniently changing a floor layout.

Permanent interior walls around the elevator shafts are 6 in. thick and of cinder block construction. These walls are entirely faced with 20-gage metal of the type used for wainscoting, except in the toilets, where tile is used.

Rafters are on a 6-ft. spacing and consist of 12-in., 25-lb. wide flange H-sections carried at the center by a longitudinal girder between the center columns and at the outside walls by struts resting on the attic floorbeams. The roofing consists of asbestos-protected metal covered by a 1-in. thick layer of insulation, then building paper, and finally copper sheeting.

Automatic heating system

The heating system is of the differentially-controlled, vapor-vacuum type. The building is divided into ten zones and each zone is controlled by nine thermostats; this makes the system very flexible and avoids overheating or under heating of any area. Steam delivered at 125 psi. pressure by two 225-hp., oil-burning boilers, which have individual forced drafts and are located in a separate structure several hundred feet from the laboratory building. A radiator is located below each window of the building. Delivery of the steam at 125 psi. also makes possible use of this supply in the laboratory areas at 5, 25, and 125 lb. pressure.

A system of forced ventilation, consisting of four entirely separate units, is provided for the portion of the building devoted to chemistry. Fresh, tempered and filtered air is forced into the laboratory areas and in turn exhausted through the fume hoods, thereby removing obnoxious fumes. The normal velocity through each hood is 720 cfm., with provision for increasing this inflow where necessary. The ventilating equipment, such as the fans, filters, and heaters, is located in the attic with supply and exhaust ducts extending vertically to the various floors.

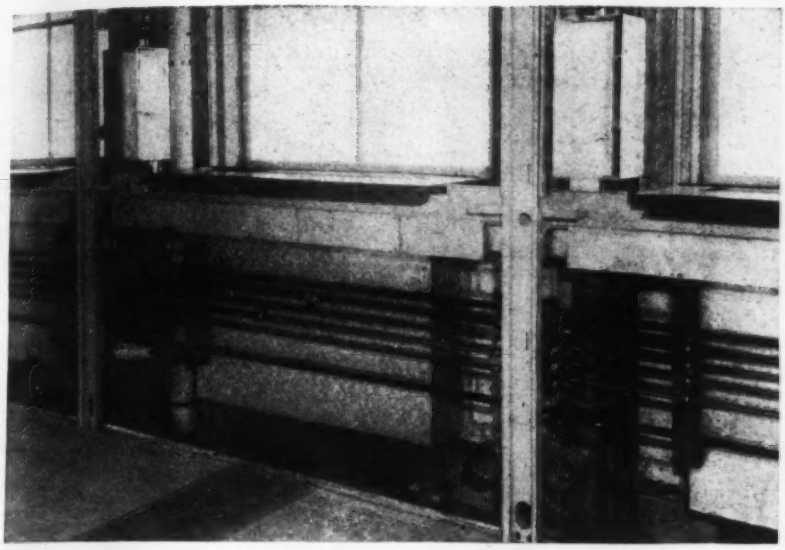


Fig. 4. Most services are supplied by horizontal runouts below 4-ft. wide windows. An 8x12-in. chase on either side of all floorbeams provides space for risers. Runouts and risers will be hidden from view by 20-gage metal wainscoting. Note method of providing drain on both sides of where transverse partitions may be needed to divide the floor area into individual laboratories.

All supply ducts are metal, but the exhaust ducts, which will be carrying chemical fumes, are 12-in. dia. ceramic tile. Where the depth of the rooms is 27 ft. at each 24 ft. spacing along the corridor wall there is located one supply and three exhaust ducts. Where the distance from the windows to the corridor is 19 ft., the spacing of the duct groups is 36 ft. These ducts are for the first and second floors only, and each duct may serve either of the two floors, but not both. The system which is planned, in general, on the basis of assigning one exhaust flue to each chemical hood, is designed to cause air to pass through the fume hoods at approximately 60 cfm. per sq.ft. of opening. The top or third floor is served by a separate group of supply and exhaust ducts. These extend only through the ceiling of this floor. They are, however, located adjacent to those serving the first and second floors.

Electrical power supply

Electrical power is received from the local power company over two separate 13,200-v. feeders to a substation located near the boiler house. At the substation the voltage is reduced to 4,150 v., and the supply is then carried underground to the building's cellar by means of two separate feeders connected to three groups of three transformers each. The transformers reduce the voltage to 120-v. single-phase and 208-v. three-phase for house distribution. By means of transfer switches each feeder may be connected to any one or all three of the transformer groups. Each group supplies power to a distribution ring main, located under the cellar floor, from which power can be taken at any central column in the area.

Connections to the ring main at each central column terminate in suitable magnetic protective devices located in distribution boxes mounted on the corridor side of the basement columns. Power for both the lighting system and the laboratories is obtained from these boxes, but the manner of distribution is different. Distribution of power for artificial lighting is by means of a riser at each center column, each riser serving a 24-ft. length of the building. Electric power for use in the laboratories is carried from every other basement column to the outside wall and then along the wall a distance of 48 feet. At 12-ft. intervals risers are installed to extend to the attic, and power is taken from each riser through a 50-amp., three-phase circuit breaker on each floor.

The method developed as a standard for distribution of power within the laboratories is somewhat unusual. Along each wall of the laboratory and about 7 in. above bench level, a 2¾x3-in. metal trough for electrical wiring is installed with an open side toward the front. The opening is closed by interchangeable cover plates. These may be either blank or equipped with various types of outlets and protective devices such that power takeoffs are possible at 66-ft. intervals.

Personnel in charge

General supervision of the project for the owners was handled by M. B. Long. James G. Motley, construction engineer, was responsible for the general design from the functional standpoint and for relations with the architects. Earl V. Mace correlated the physical requirements of the groups to occupy the structure, while Charles A. Chase was resident engineer during construction. For Voorhees, Walker, Foley & Smith, New York, architects for the project, S. F. Voorhees and Ralph Walker were in charge of design and Charles Haines was project manager. John Lowry, Inc., New York, with L. E. Sheldon in charge and S. C. Ketcham general superintendent, was the general contractor.

Fig. 5. Transverse partitions can be quickly installed from 4-ft. wide panels of same height and type as those used for corridor walls. Each panel is made up of two thicknesses of 20-gage metal separated by layer of rock wool. Metal wainscoting, which may be quickly installed, will cover piping shown.

Substructure of bridge over Miraflores locks takes shape in preparation for construction of a new set of locks to be located on the near, or west side, of the Panama Canal. The round piers are pivot piers for the two bobtail swing spans required.

Bridge Joins Continents at Panama Canal

***Contents in Brief**—Two bobtail swing spans are being built over the Miraflores locks of the Panama Canal, providing the first rail and highway connections between the continents of North and South America. Each span consists of a long and a short arm, 184 and 92 ft. long, respectively. Operation of the bridges will be coordinated with lock operation. The bridges will first be used to give access to the construction site for the new Miraflores locks on the west side of the canal and will later be the connecting link with Canal Zone highway networks on the east and west banks.*

FEW BRIDGES HAVE BEEN BUILT on a location having an historical background comparable in significance with the Miraflores bridge now being constructed over the present Miraflores locks near the Pacific terminus of the Panama Canal. Besides being the first permanent crossing of the canal, the new structure will rejoin the continents of North and South America, which were separated over twenty-seven years ago by the completion of the great interoceanic waterway. Primarily, the bridge is being constructed to provide railway and highway access to the west side of the canal during the construction of the third set of locks. However, the bridge will remain a permanent crossing after the new locks are completed and, with a proposed second bridge over the new locks, will join the Canal Zone highway networks on the east and west sides of the canal.

The bridge is composed of two independent movable spans, each of the "bobtail" swing type. Each movable span will consist of a long arm of 184 ft. and a short arm of 92 ft., the main supports for these spans being two similar reinforced-concrete pivot piers 34 ft. in diameter located outside of, and immediately adjacent to, the east and west side walls of the twin locks. The elevation of the top of the piers is 17 ft. above that of the locks walls to permit liberal clearance for the locks' towing system.

The approach to the bridge from the east will begin at a junction with the main line of the Panama Railroad and the Gaillard Highway, the latter one of the principal arteries of the Canal Zone highway network. From this point the approach will continue a distance of 787 ft. over a 70,000 cu. yd. fill and thence over a 1,675-ft. steel viaduct to the east end pier of the bridge. This viaduct, supported by 27 reinforced-concrete piers, will extend across the low, swampy Rio Grande Valley on a 4 deg.–46 min. curve. The viaduct footings rest on 1,100, 16 x 16-in. precast concrete piles, from 24 to 48 ft. long and driven to rock. Accommodating a 22-ft. roadway and a 3-ft. sidewalk separated from a 5-ft. gage railway track, the viaduct deck will be carried by 62-ft. simple span plate girders.

The approach from the west will run over a 115,000 cu. yd. fill joining the west abutment (which also acts as a rest for the west span when in a closed position), and Bruja Road,

which is to be relocated so as to lead over the new locks via the proposed second swing bridge.

The bridge deck also will accommodate a 22-ft. roadway and a 3-ft. sidewalk, but the railway will run down the center of the roadway instead of alongside as on the approach viaduct. The roadway will consist of 12,700 sq. ft. of open type grating 5 in. in depth, with main carrying elements transverse to the direction of the traffic in order to provide a smooth riding surface of regular pattern. The deck will be supported by two non-parallel-chord Warren trusses located 28 ft. on centers, each truss made up of 12 panels of 23 ft. each. A total of 1,225 tons of structural steel is required for the two spans.

The movable spans will be operated electrically by two identical 30-hp. 750 r.p.m. wound-rotor induction-type motors. With normal voltage and frequency applied to the motor terminals, a maximum torque of not less than 275 percent of full-load torque will be developed.

There will be two 220-volt, 3-phase, and 25-cycle brakes with a retarding torque of about 160 ft. lb.; supplementing these brakes will be two thrustor-released, spring set shoe emergency brakes, each brake having a retarding torque of 600 ft. lb.

The opening and closing time for the bridge with a wind load of 2½ lb. per sq. ft. acting on the long arm only will be 2½ min. Auxiliary motive power will also be provided to operate the spans.

To insure complete safety in operation, the entire control system is to be interlocked with the locks' guard chains in such a manner that neither chain in the east or west chamber can be lowered to permit ship passage until the corresponding bridge span is completely opened. To accomplish this, all signals for opening and closing will be transmitted from the locks' control tower to the east and west span operating towers located on the east end pier and west abutment, respectively. All signal lights, warning bells, barrier gates and other bridge control appurtenances will likewise be tied into this interlocking system.

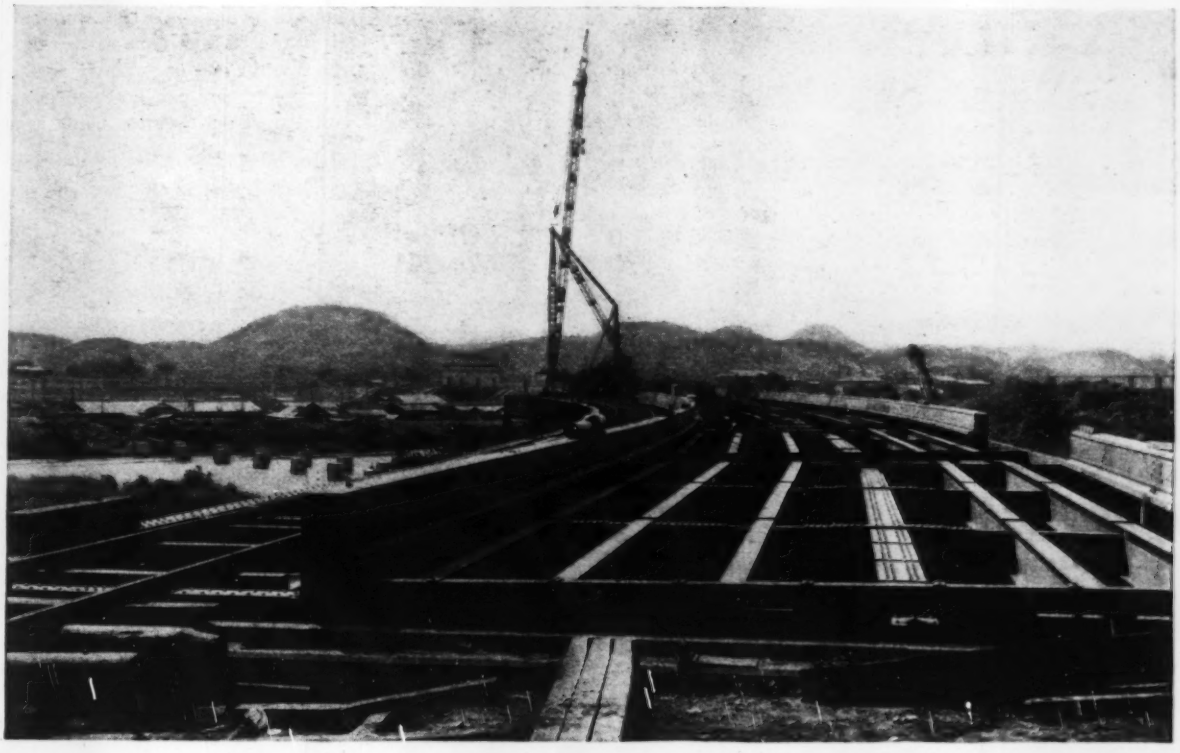
In order to avoid any interference with canal traffic, the two spans will be erected in an open position on falsework along the east and west walls of the locks. When the two spans have been completely assembled, they will be lifted by calibrated, hydraulic jacks to weigh the spans and determine the amount of concrete necessary to balance the short arm with the long arm. When in operation and in an open position, the ends of the spans will seat on two rest piers located northwest and southeast of the pivot piers on lines parallel to the east and west sidewalls of the canal.

The center rest pier, upon which the two spans seat in a closed position, is located directly over an arched opening provided in the 60-ft. middle wall of the canal to give access to the locks' gate bridges across the canal. In order to permit the arch to carry the additional load, adequate supports from below had to be constructed.

The design of the bridge was prepared by the consulting firm of Sverdrup and Parcel, St. Louis, Mo. The substructure, which is practically completed, is being constructed by the Municipal Engineering Division, a unit of the regular Panama Canal organization. The fabrication and erection of the superstructure are being done under contract by the Pittsburg-Des Moines Steel Co., Pittsburgh, Pa., at a cost of $1,078,840.

The work is being carried on under Act of Congress approved Aug. 11, 1939, which authorizes the construction of additional facilities for the Panama Canal, providing for a third set of locks. Col. T. B. Larkin, C. E., supervising engineer, is in charge of this project of The Panama Canal, and Lt. Col. Hans Kramer, C. E., is the construction engineer.

Viaduct deck carries vehicle roadway and railway side by side. On the swing spans over the canal the rail line is brought over to the center of the roadway to reduce the distance between trusses of the swing spans.



How to Line Canals with Brick

W. I. Gilson
Engineer
Valley Clay Products Co., Brownsville, Tex.

***Contents in Brief**—In 1933 brick was used for the first time to line southern Texas irrigation canals. Extensive similar work since then has proven reinforced brick masonry a highly satisfactory lining. Advantages of this type of construction are explained and correct construction procedures are described.*

A DECADE OF WORK in lining southern Texas irrigation canals with brick has proven this material highly satisfactory for such a purpose. Construction of the first brick-lined canal in that area was by the writer in 1933, when a 500-ft. long section was lined with salvaged brick. The first trial of a reinforced brick masonry section was constructed in Hidalgo County Water Control and Improvement District No. 7 at Mission, Tex., in April, 1935, by Hill Cooke and Guenther Weiske in collaboration with the district. Both of those projects are still in service and show few signs of deterioration. Extensive similar work since those jobs were completed has given fuller knowledge of how to obtain even more satisfactory service through the use of better materials, designs and construction procedure.

Advantages of reinforced brick lining for canals include:

(1) Cross cracks due to contraction rarely occur and buckling caused by expansion is entirely eliminated. The principal cause of failure of linings heretofore has been formation of cross cracks, which is followed by seepage and subsequently by displacement of the side slabs due to uneven moisture conditions in the supporting banks.

(2) Brick lining is adaptable to construction in semicircular cross-sections, which makes possible the maximum hydraulic efficiency and carrying capacity.

(3) Cost of the brick, which is the major material required, is low.

(4) Highly skilled labor, except for supervision, is not essential, since laborers of average intelligence after a few hours training are satisfactory for all the operations required. This includes finishing, which is the most important in securing good appearance and a low friction coefficient.

(5) Equipment required is neither extensive nor costly. This makes brick lining adaptable to jobs where the owner desires to do his own construction work and to small jobs where the cost of moving large equipment would be a considerable item. (Many canal-lining projects in the Rio Grande Valley have been sponsored by irrigation districts as WPA projects because of the hand labor involved.)

(6) Since the thickness of the brick determines the minimum thickness of the lining, the risk of there being undetected thin areas due to poor workmanship is eliminated.

Cost of lining

Records indicate that within the past few years over ten million bricks have been used in the United States for canal-lining purposes. Much of this work has been on a large number of small projects under conditions where costs could not accurately be ascertained. However, from data that are available, the cost of reinforced brick masonry lining appears to run about on a par with that of concrete lining. That is, the cost for brick, mortar and wire is about 6.2c. per sq.ft. of lining. Labor costs will bring the total, under normal labor conditions, to about 11c. per sq.ft. on medium-sized jobs, slightly less on large projects, and correspondingly more on very small ones.

Construction methods

A successful method for constructing a brick lining with reinforcing consists of the following steps:

Staking out—The engineer's work in staking out a canal for a brick lining is identical with that for a concrete lining. The grade stakes, which are usually set one foot out from the lining edge to prevent their displacement, are located on 12½-ft. intervals. Only those on one side of the canal are set by the engineer, since those on the opposite side can be set to grade by the construction crew while using

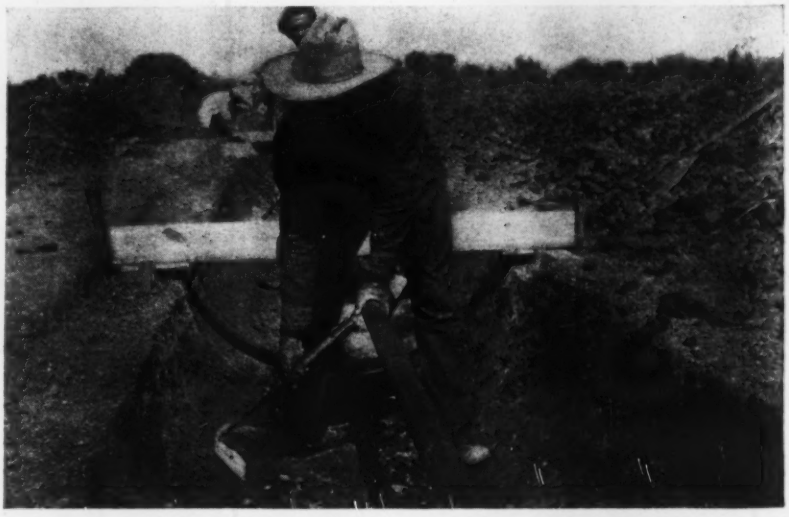


Fig. 1. On a small canal this revolving hoe method of trim works very well.

Fig. 2. Reinforcing has 6x12-in. openings and longitudinal wires are 10 gage, while cross wires are 12 gage. Longitudinal grooves on the edges of the bricks help in keeping the reinforcing in place and with the holes in the ends serve as motar locks.

an ordinary straightedge and hand level.

Shaping canal—This operation is usually classified into rough trim and fine trim. Rough trim is done with a dragline or other power machinery, where possible, on sections over five feet in diameter. Considerable care is warranted in getting the cut to within three or four-tenths of a foot of finished grade, as the cost of the next operation is much reduced thereby. For fine trim, two cross-section shapes predominate, the full half-circle and the 160-deg. arc. Either of these can be shaped by the revolving hoe method, illustrated by an accompanying photograph.

Placing reinforcing—The reinforcing wire currently used has ten-gage longitudinal and twelve-gage cross wires with 6x12-in. openings. The roll of wire is laid crosswise the canal and upon being unrolled the wire gradually settles to take the shape of the canal section. Each longitudinal wire at the starting end is securely staked down, while all wires at the opposite end are fastened to a curved templet shaped to fit the canal, as illustrated in Fig. 3. A chain hoist attached to the templet pulls the wire taut to make the canal ready for laying brick.

Placing of brick—The bricks are distributed along the canal in piles about 50 ft. apart. To soak the brick to partial saturation, which requires but a few minutes, a soaking box is placed on the canal levee. The soaked units are removed from the near side of the box for passing to workmen in the canal, while at the other side of the box bricks are added from the stock piles. Thus, during the placing operation, they are continuously passing into and out of the soaking box. Brickwork two courses in width is first placed in the bottom of the canal to provide a long strip one foot wide on which the other bricks are piled for the bricklayers. Bricks are placed in the mesh openings, placement requiring no special skill, but it is important to select men for this work who are naturally adept with their hands. On large projects crews are assigned to each of the operations and this is the ideal arrangement, as the crews tend to become specialized and hence more efficient. Bricks are laid along several hundred feet of the canal before commencing the next operation.

Application of mortar—A mortar with a one part cement to three parts sand is very good. On larger projects use of a 2-yd. or larger transit mixer to prepare the mortar has been found economical and conducive to speed. The mixer should be stationed within easy reach of the canal and the mortar delivered sufficiently liquid to permit it to be worked by push brooms into the joints and through them to the earthen foundation, thus completely imbedding the reinforcement. As the mortar is broomed, the partially saturated bricks absorb the excess moisture and the mortar is soon stiff enough to stay in place even on the upper edges of the canal perimeter. All cross and longitudinal joints are next struck with a jointing tool to further insure contact of mortar with the earthen foundation and to secure coverage of the reinforcement. The coarse push brooms do not leave a smooth surface so that a finisher follows up with a broom of finer bristles. Men with trowels work between the coarse brush crew and the finishing crew to bring the rim to grade and alignment. A mortar of troweling consistency is used for the rim finishing.

Curing—It is always advisable to start work at the canal's upsteam end and to have stored an adequate supply of water, which can be released as required for curing new work. Thus, when the canal has seasoned for about 12 hr., an earthen dam can be constructed at the downstream end and the new canal filled as full as possible with water. Parts not submerged should be sprinkled, splashed frequently, or kept covered with wet fabric. Within a few hours after the lining has been completed the canal can be placed in service.

Fig. 3. Construction procedure once brick and reinforcing are in place. In the foreground is the semicircular templet to which the reinforcing wire is secured; beyond, successively, are a pushbroom operator, joint striker, and finisher.

The first Texas canals were lined with native brick of standard dimensions, but five advantages were seen if a larger brick could be used. These were: (1) cost of brick per square foot of area covered would be reduced, since the increased manufacturing cost for larger units would not be in proportion to the area increase; (2) saving of labor in laying the brick; (3) less mortar required per square foot of lining; (4) proportion of mortar to clay product would be lessened by a longer brick; and (5) due to the difference in thermal coefficients of the brick and mortar overall contraction and expansion would be slightly reduced.

These considerations led to the final selection of a brick measuring $1\frac{5}{8}$ x $5\frac{1}{2}$ x $11\frac{1}{2}$ inches. The most satisfactory type is also scratched or scored to increase the strength of mortar bond. Likewise each brick contains four tubular holes running lengthwise to provide: (1) a saving in weight that reduces the cost to the manufacturer and (2) added slab strength which is most important. When the joint mortar is applied there is a slight protrusion into the tubular holes and these protrusions act somewhat as dowel pins and add strength in maintaining alignment. Further study may warrant further dimension changes but it is believed they will not be radical.

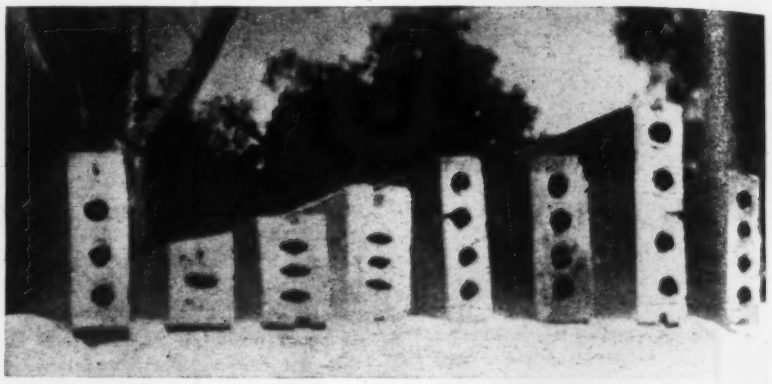


Fig. 4. Various types of brick which have been manufactured for canal-lining purposes. That at right is the latest.

The question naturally arises as to advisability of further increasing brick length to further reduce the thermal coefficient of the masonry slab. In long units some curvature often results in manufacture and kiln drying and this would be objectionable, if extensive. Thickness can easily be increased, and probably will be, to meet different hazards and to adapt brick to very large-sized canals.

Public Health Engineering Stressed at University of Michigan

SPECIAL EMPHASIS on training sanitary engineers in the broader aspects of public health engineering has been undertaken by the School of Public Health at the University of Michigan, Ann Arbor. The courses are designed for graduate engineers only and lead to the degree of Master of Public Health.

A recent article in the *News Letter* of the school, written by H. E. Miller, under whose direction the program has been developed, points out that the courses have been designed to:

1. Familiarize public health workers with the basic fundamentals of sanitation as it may be involved in their several fields. The topics covered include the usual subjects such as water, milk, food, excreta disposal, rodent and insect control, industrial sanitation, and other problems.

2. Train engineers and others with adequate background in sanitary science to perform the specialized engineering services required in modern public health endeavor. The work of this division is designed to prepare personnel specifically for: (a) local health department sanitation service, with emphasis on rural problems; and (b) state health department service, including consultation service to both city authorities and local health units. Special attention is given to municipal sanitation, especially water supply, milk supply, sewerage, the disposal of industrial wastes, industrial sanitation and stream pollution matters.

Field applications stressed

Practical application receives major attention in all of these courses, stated Mr. Miller. This is emphasized in the laboratory courses in which material from typical field problems forms the basis for problems of study. The work of this field has been materially strengthened through the addition of Dr. G. M. Ridenour, formerly of Rutgers University, to the staff. His broad experience in research and plant operation has been drawn upon extensively to give practical application to the laboratory and field studies.

The school is particularly fortunate, said Mr. Miller, in having a field laboratory available for the study of rural sanitation problems. The installation of private sewage-disposal systems, sanitary privies, and private water-supply improvements are planned and supervised for farm homes by the students as individual class problems. Twenty homes are included in this year's work. Since many types of wells are involved, experiments are being made with several different methods of well improvements. In addition, the university facilities are used to provide the students with problems for the study of swimming pool supervision, food and restaurant supervision, and plumbing safeguards.

A limited amount of research is underway at this time, and it is intended to expand this phase of the work as space and facilities become available. This effort will be directed toward problems in which the information derived from studies would be useful to administrative health agencies.

Fig. 1. The 500-watt central control station (KFCD) which transmits to field crews from the roof of a Los Angeles office.

Radio for Flood Emergencies

Maurice E. Kennedy
Communications Engineer
Los Angeles County Flood Control District

***Contents in Brief**—Two-way radio, replacing telephone lines which are unreliable in times of heavy storm, greatly increases the efficiency of patrol and repair crews operating in rough mountainous terrain where the Los Angeles County Flood Control District control works are located.*

RELIABLE COMMUNICATION is essential to effective operation of flood-control and water-conservation works in the back country of Los Angeles County where deep narrow canyons and precipitous mountain slopes are included in the 1,586 sq. miles ranging from sea level to elevations of more than 10,000 ft. Despite the high standards of modern telephone line construction, many hazards still beset telephone lines in such terrain. Wire lines cannot withstand landslides, forest fires, electrical storms, falling trees, willful sabotage and windstorms.

Because of the vital importance that often attaches to maintaining communication between a central office and emergency crews in the field, special emergency radio stations are now being operated by numerous public utility companies, highway maintenance departments and similar organizations. In recognition of this need, the Federal Communications Commission has designated four frequencies of medium range and thirteen in the high frequency range for emergency communication of this sort. Limitations are imposed to prevent use of these stations except in emergency when other forms of communication fail or where they do not exist. The emergency stations may not handle non-emergency or routine communications and equipment testing is limited to two minutes in each half hour or, where longer tests are needed, to a total of four hours in a seven-day period.

Long experience with the danger of interruptions to wire communications led the Los Angeles County Flood Control District to establish an emergency radio communication system in 1935. From the small beginning of two radio stations for emergency use between an isolated dam and the district's hydraulic dispatcher's office in Los Angeles, the use of radio has increased to 16 two-way radio units and a fleet of 48 trucks and field cars equipped with receiving sets.

The central station in the downtown office building where the Flood Control District's office is located, is equipped with a 500-watt transmitter. During storms this station communicates directly with the field radio stations and is also used to transmit weather information, stream-flow data, rain gage station reports, emergency calls to trucks, and general storm information to engineers and emergency crews in the field.

Field stations of 50 or 100-watt power, depending on the remoteness of the location and the efficiency of the radiating system, are located in

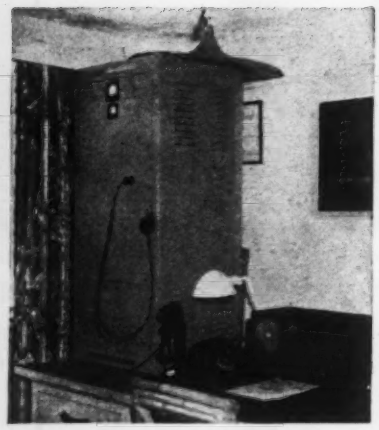


Fig. 2. Interior of a 50-watt field station (KAOP, at Puddingstone Dam). This is typical of the transmitters on the smaller dams.

the operating offices or control rooms at the flood-control dams, some of which are in deep canyons separated from the central offices by high mountains. Other stations are at the central warehouse, a pumping plant, various field offices and in the radio-equipped trucks and cars. The portable units, mostly of 50-watt rating, are complete with alternating current power supplies and are kept in readiness for instant use in their mobile form or on transfer to some emergency field headquarters. The power rating of the stations located on the open coastal plain away from the mountains is 50 watts. Small battery-operated units in each of two communications cars have a 10-watt power rating.

The radio receivers used in the patrol trucks and cars driven by field engineers are of a standard police-patrol-car type. These receivers are fixed-tuned to the frequency of the district's main radio station and loud speakers are mounted in the driver's compartments. Each car is assigned a radio-car number, as is the case with police cars, and they are called by the driver's name and car number.

The dispatching of emergency crews and trucks by radio has greatly increased the efficiency of dealing with storms and floods. The time interval between the telephone call from a person reporting a clogged storm drain, or a flooded condition, and the actual arrival of an emergency crew has been reduced to a matter of minutes. Numerous cases are on record of the radio trucks reaching flood-threatend areas in time to prevent serious flood damage.

These patrol trucks operate from field districts which have a local field office in each district. Two of these offices have 50-watt stations to insure reliable communication during failures in telephone service. It is highly important that these field offices keep in touch with the central dispatcher and the central warehouse during major storms. These stations also make it possible for the local offices to call the radio trucks.

Radio cars driven by district engineers and hydrographers have modified receivers for the reception of the airway weather stations as well as the district's short-wave stations. Weather and storm movements are of importance to these field men. Field investigators may also be directed to inspect dangerous conditions and report to the dispatcher's office during major storms.

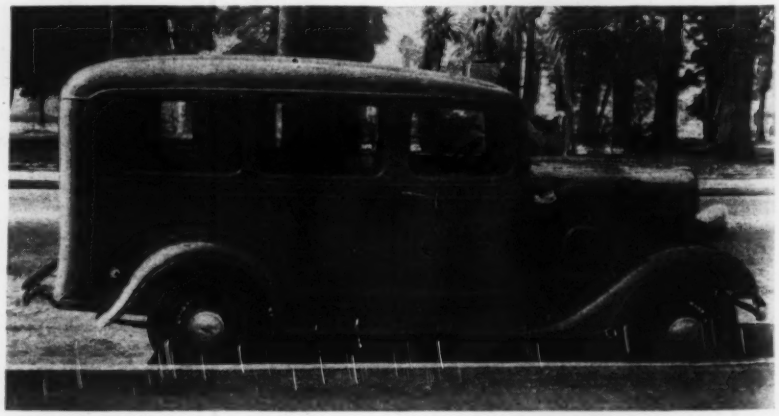
Distances between stations on the district's dams and the central office in downtown Los Angeles range from 25 to 40 miles. However, the rugged terrain of the mountain area over which the signals must pass make the attenuation equal to distances of several hundred miles of open country. Due to the high induction noise level at the central station in Los Angeles and attenuation of signals on the frequencies used by the district's stations during the daytime hours, reception has always been difficult during the day. This condition has just been overcome by the development of a repeater station which takes advantage of favorable radio conditions on an outstanding promontory rising to El. 1,900 in the coastal plain. On this summit there is (a) relatively good radio reception, day or night, from the district's mountain and field stations and (b) a direct line of sight to the distant office in downtown Los Angeles where the district's headquarters are located. This direct-vision feature facilitates good transmission at very short-wave lengths.

Experimental work resulted in the development of automatic relay equipment for this summit which can be started up by the dial tone of a carrier wave. The automatic station then retransmits on a 310,000 kilocycle wave which is picked up by a specially constructed receiver on the roof of the office building in Los Angeles where the district's head office is located. In this manner reception is greatly improved without the need of connecting wires.

The district's radio section has carried on extensive experimental work in connection with the development of equipment and radiating systems for greatest efficiency on the special emergency frequencies, namely 2,292, 2,726, 3,190 and 4,637.5 kilocycles in the medium frequency bands as well as 31,460, 31,470, 33,060, 33,820, 35,140, 37,180, 37,820, 39,340, 39,660, 39,860, 116,650, 117,850 and 159,825 in the higher-frequency range. Extensive experimental work has also been carried on with frequencies of 300,000 to 400,000 kilocycles.

The transmitters now in use were designed and built by district personnel under the general direction of Paul Baumann, assistant chief engineer. H. E. Hedger, chief engineer of the Los Angeles County Flood Control District, is responsible for authorizing the progressive steps taken in the development of a modern communication system.

Fig. 3. The 50-watt portable radio transmitter (KINT) in this truck is typical of the mobile sets used by patrol and repair crews.



From Field and Office

Working problems and time-saving methods for engineers and contractors

Vertical Curves Solved by Slide-Rule

The problems of finding tangent slopes on vertical curves and of transforming vertical curves to fit changed slopes of approach grades, as presented by W. E. Cooper (*ENR*, Sept. 11, 1941, p. 377) and Samuel Gisser (*ENR*, Nov. 20, 1941, p. 747), submit to a simple slide-rule solution used for several years in the Rochester office, New York State Division of Highways. This method is based on the fact that the correction in elevation, from tangent grade at any fixed point on a vertical curve, say 100 ft. from the P. C., determines the curve involved; and once this value, C_{100}, is established it remains constant for that curve regardless of any change in length of the curve and change in the rate of either or both approach grades. This relationship is expressed in the well-known V. C. formulas:

$$C_{100} = \frac{G_1 - G_2}{2L} \qquad (1)$$

$$\frac{C_x}{C_{100}} = \frac{X^2}{100^2} \text{ or } C_x = \left(\frac{x}{100}\right)^2 C_{100} \qquad (2)$$

Where: C_{100} = Correction from tangent 100 grade ft. from end of curve
$G_1 - G_2$ = algebraic difference in grades
L = lenght of curve in stations
x = any distance from one end of curve
C_x = correction from tangent grade at x

To obtain the slope at any point on the curve, G_x, x distant from the end, substitute G_x for G_2 and x for L in (1): transposing

$$G_x = G_1 - 2x\,C_{100} \qquad (3)$$

When a new length of curve (L) is desired for any different rate of grade, as G_x for G_2 and L_x for L in (1). Thus,

$$2L_x = \frac{G_1 - G_x}{C_{100}} \qquad (4)$$

This method is particularly adaptable for use on the slide rule. With one setting of the slide, one can obtain the correction from tangent elevation for any point on the curve; the length of curve for any desired change in rates of tangent grades; the algebraic difference in rate of grade for any length of curve; and, if one rate is known, the slope at any point by a simple subtraction.

For example: Given the same problem as in Mr. Gisser's article, viz.: a plus 6 percent grade intersecting a minus 4 percent grade and the V. C. equal to 600 ft. Setting $2L$ (12) on B scale under $G_1 - G_2$ (10) on A scale we find the value of $C_{100} = 0.833$ (on A scale over index B). With this setting of the rule it is evident that any value of $(G_1 - G_x)$ on the A scale is directly over the corresponding value of $2L_x$ on the B scale. Thus changing the plus 6 percent to a plus 4 percent, giving an algebraic difference of 8 percent (A scale), we find the value of $2L_x$ to be 960 ft. or $L_x = 480$ ft. Then 600 ft. $-$ 480 ft. $=$ 120 ft., the distance from old P. C. to new P. C. Then, changing the minus 4 percent to minus 3 percent for the algebraic difference of 7 percent we find the value of $2L_{x1} = 840$ ft. or $L_{x1} = 420$ ft. whence 480 ft. $-$ 420 ft. $=$ 60 ft., the distance from old P. T. back to the new P. T. The new elevations are a matter of simple arithmetic.

To determine the slope at any point, say 300 ft. from the P. C. of original curve, over 2_x (6) on B we read $G_1 - G = 5$ percent on A, substituting $G_x = 6$ percent $-$ 5 percent $= +$ 1 percent.

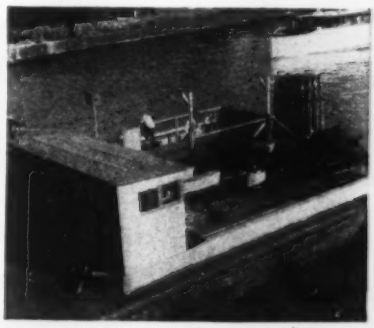
To find the summit of the original curve, under 6 percent (on A) we find $2L_0 = 720$ or $L_0 = 360$ ft. from P. C.

Also from this same setting of the slide rule we read, on the A scale, the correction from tangent grade to any point on the curve, over the corresponding distance from P. C. or P. T. on the C scale.

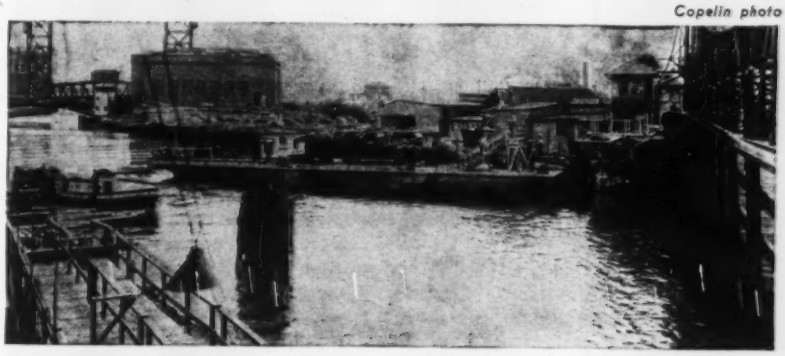
Where the slide rule does not give the desired accuracy, as in the case of long vertical curves, the value of C_{100} can be computed and the correction from tangent grade obtained by the

SCOW PROVIDES TEMPORARY PONTOON CROSSING AT CHICAGO

WHEN THE CERMAK ROAD BRIDGE over the Chicago River at Chicago was closed recently for repairs, a 120-ft. long scow was used to provide a temporary pontoon crossing. The bridge could be opened and closed to permit the passage of river traffic, since the pontoon was moored at one end to a pile clump around which the temporary bridge revolved in an arc of about 90 deg. The bottom photo shows the bridge open to permit passage of boat. The scow, as shown by the upper photo, is swung about by a paddle wheel, of the old Mississippi River steamboat type, operated by a 50-hp. electric motor on the scow. About 1¼ minutes are required to open the pontoon and strong winds cause no trouble. W. W. De Berard, city engineer of Chicago, was in general charge of repairing the existing structure.

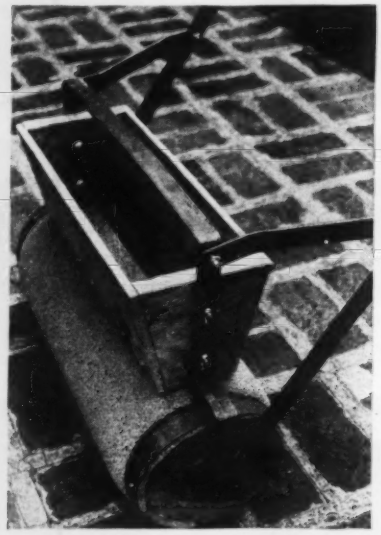


Copelin photo



aid of a table of squares, calculating machine and Equation (2).

Based on values of C_{100} a convenient table was worked out for the minimum sight distance on the curve and the degree of circular curve, standard scale 1 in. = 100 ft., which will most nearly approximate the V. C. on the distorted scale 1 in. = 10 ft. vertical and 1 in. = 50 ft., horizontal commonly used on highway profiles in New York state.—C. M. BENNETT, *State Division of Highways, Rochester, N. Y.*



Applying Separating Agent On Brick Pavements

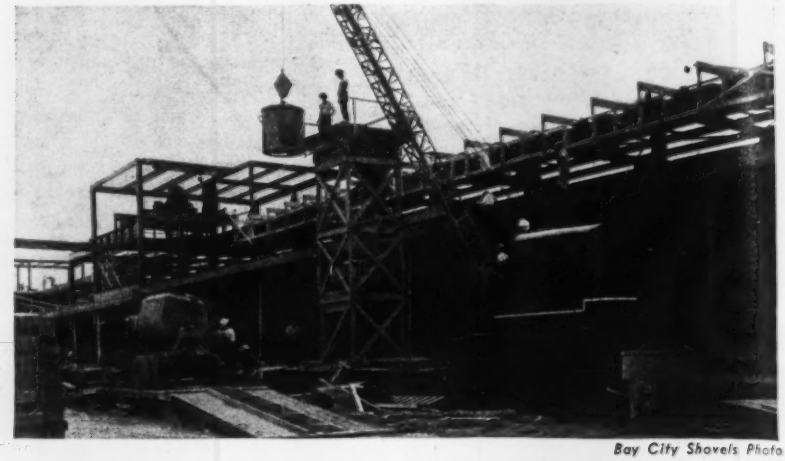
To aid in keeping the separating agent for removing excess joint material on brick pavements from flowing into the joints and preventing the desired adhesion of the asphalt filler the National Paving Brick Association has developed the device shown above. The roller is a solid wood cylinder 6 in. in diameter and 20 in. long. It is covered by a 1-in. sponge rubber sleeve with the outer skin removed to expose the pores. Suspended immediately above the roller is a wooden feeding hopper, the bottom edges of which are trimmed with flexible rubber squeegee wipers. The hopper may be moved vertically to vary the rate of application.

As a further development the association found by experimental work that a mixture by weight of 64 percent water, 31 percent calcium chloride, and 5 percent starch was an excellent separator of the desired viscous property.

Loading Crane and Tower On Flat Car Speeds Defense Job

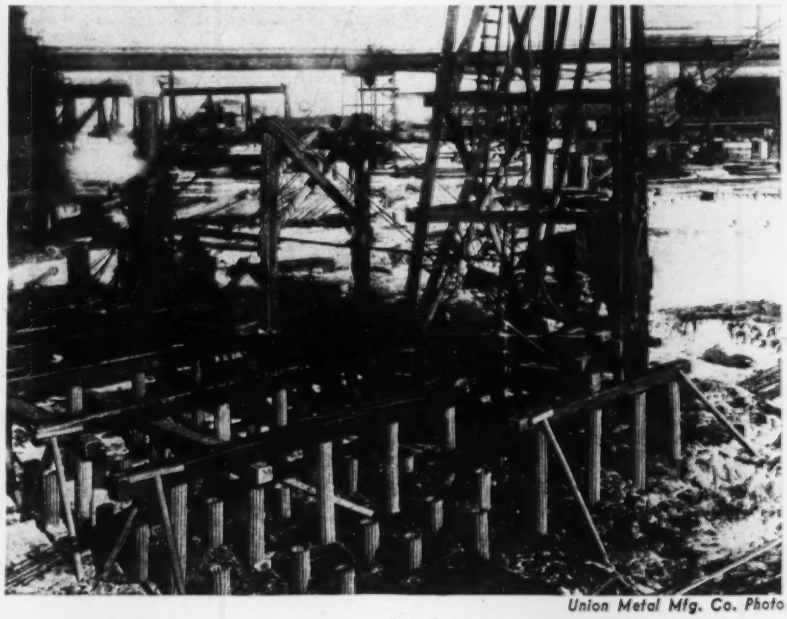
On a St. Louis, Mo., ordnance plant the Fruco Construction Co. is saving a lot of time due to putting a ¾-yd. diesel crane and 45-ft. high concrete tower on a 50-ft. long railroad flat car. The equipment is being used for a 1,200-ft.-long building and the flat car is moved from one setting to the next by fastening a dragline cable from the crane's front drum to a tie or rail. Crane is also used to move ramp for truck mixer when necessary.

The bin at the tower's top is equipped with two chutes—one for the first floor and one for the second—making it possible to place concrete for two floor levels without moving the equipment or changing chutes. The concrete is handled in a 1-cu.yd. bucket on a single line.



Bay City Shovels Photo

Towers and cranes on a railroad flat car, speeds concrete handling.



Union Metal Mfg. Co. Photo

STEEL PILE EXTENSIONS USED TO SUPPORT DRIVING EQUIPMENT

PICTURED ABOVE is an arrangement that saved considerable in construction costs on a 900-ton capacity blast furnace. Instead of the usual expensive method of wood cribbing underneath the pile driver, the contractor used the steel piles for this purpose. The steel pile casings were driven to an 85-ft. depth in one piece, short extensions then tack-welded intermittently to the pile tops, cap timbers laid across these extensions, and the driving rig moved into position. The rigidity of the steel piles eliminated any necessity for cross bracing, as shown in the illustration.

Book Notes and Reviews

The month's addition to the engineer's reading and reference list

Air Raid Protection

AERIAL BOMBARDMENT PROTECTION—By Harold E. Wessman and William A. Rose. 372 pp. John Wiley & Sons, Inc., New York; Chapman & Hall, Ltd., London. $4.

It is fitting that Harold E. Wessman and William A. Rose should be the authors of the first American book on the technology of air-raid protection, for these two New York University professors were among the first to delve into the possibilities of designing to resist bombs and theirs have been the most potent voices in stimulating widespread study of these possibilities by the American engineering profession. What they have been discussing in their classes for practicing engineers at N.Y.U.—and more, too—is presented in this book. Any engineer, and not a few laymen, will find it to be interesting and profitable reading.

With considerable truth it may be said that the authors devote the first half of the book to proving, first, that no rational method exists for designing structures to resist direct bomb hits and, second, that no usable structure can resist such a hit anyway. However, this proves to be neither a waste of paper nor of effort, for out of the considerations discussed emerges a clearer understanding of the bomb-resistant design problem than any of the British publications that have reached this country have yet been able to portray. And, furthermore, it provides a springboard for development of rational design methods for a problem that is solvable, that of designing to resist the effect of near misses. In any air raid, more buildings are missed than are hit.

As to the contents of the book, they divide into several quite distinct parts. After establishing the nature of this new problem in design by discussion of bomb types and characteristics, the subject of direct hits is taken up and explored by consideration of designing for impact and designing for energy loads. Next, blast, shock and fragmentation actions are explored, followed by the design of wall panels to resist blast. What might be called a third division is devoted to aerial-bombardment damage in foreign countries and the lessons that the wreckage holds. This sets the stage for the next division—one of the most useful in the book—an analysis of building requirements and suggested designs for specific types of buildings. Several chapters are devoted to air-raid shelters and to shelter zones in buildings, and there is a chapter on protective concealment, i.e., camouflage. The appendix contains a discussion of vibration of structures as a result of explosions. This is by Prof. James J. Stoker, of N.Y.U.; the appendix also makes available a brief of the Edgewood Arsenal tests of structures under bombing.

In total, the book covers in greater or less degree about all that is now known of aerial-bombardment protection. It is an excellent start in a field that needs wide cultivation and enrichment.

Flow of Water in Pipes

EXPERIMENTS UPON THE FLOW OF WATER IN PIPES AND PIPE FITTINGS—By (the late) John R. Freeman. 349 pp. American Society of Mechanical Engineers, New York. $8.

After a lapse of half a century a detailed account of Freeman's classic experiments on the flow of water in pipes and pipe fittings has been made available in a handsomely printed and bound volume.

An explanatory foreword by Clarke Freeman, editor for the John R. Freeman Trust Estate, and son of the great engineer, explains the delay in publishing the report and correlates it with several notable later studies in the same field. Tribute is paid to Clifford P. Kittredge for checking all the original field notes and working out the experiments to conclusions. In doing the latter, Dr. Kittredge used Reynolds Numbers instead of plotting friction factors against velocity, as was customary when the experiments were made. In the body of the book, apparatus used in the experiments are described and illustrated. Work sheets are reproduced in facsimile. A frontispiece portrait shows the strong and genial face of Freeman with the quizzical look befitting one of the world's greatest searchers for scientific truth.

The book is a worthy memorial to a great hydraulic engineer. It deserves a place in all libraries, public or private, that seek to include notable works on hydraulics.—*Reviewed by* M. N. BAKER, *associate editor, retired, Engineering News-Record, Montclair, N. J.*

About Highways

AMERICAN HIGHWAY POLICY—By Charles L. Dearing. 286 pp. The Brookings Institution, Washington, D. C. $3.

HIGHWAY ECONOMICS—By Harry Tucker and M. C. Leager. 454 pp. International Textbook Co., Scranton, Pa. $4.

AMERICAN HIGHWAY PRACTICE: Vol. I—By L. J. Hewes, 459 pp. John Wiley & Sons, New York; Chapman & Hall, London. $5.

Three aspects of American highways are discussed in these recent books. "American Highway Policy" is another of those objective studies for which The Brookings Institution is well known. It is addressed to the average citizen rather than the specialist, its purpose being to clarify issues raised by propaganda disseminated by the railroads and other interested parties. The author discards as impracticable any attempt to equalize the competitive relationships between highway and rail transport. Likewise he discards the proposed public-utility concept of road management. He would have each state designate a "general purpose road system" that would be supported primarily out of special imposts levied against motor vehicle users, which would be based in part on "road occupancy." This latter would include special assessments against unusually large or slow-moving vehicles. Administrative and financial responsibility for these roads would be a state function. Administrative and financial responsibility for the remaining rural roads would be vested in local government units, to be supported by general tax levies on all rural properties supplemented by such general funds as the community deems appropriate. Though addressed to the general public, this book provides thought-provoking reading for

highway engineers and administrators.

"Highway Economics" is written for highway engineers and students. It brings together in concise form pertinent data on the economic aspects of highway design and operation developed in recent studies of state highway departments, the Public Roads Administration, Highway Research Board and other research organizations. Much space is given to the cost of motor vehicle transportation and to the effect of grades on such costs.

Basic engineering data relating to the location, design and construction of highways is to be included in the two-volume work by L. I. Hewes of the Public Roads Administration, "American Highway Practice". Volume I covers highway reconnaissance and location; the general problems of design such as curvature, cross-section, grades and intersections; landscape considerations and intermediate types of surfacing. Multi-lane highways are considered briefly in an appendix. Volume II will take up higher types of pavements. Like the new volume on highway economics, this book brings together in usable form the significant results of recent research relating to highway materials and construction processes. Long observation of the practical application of theory to actual highway work gives the author unusual facility in evaluating this new knowledge. Comprehensive bibliographies at the end of each chapter are a valuable element of the book.

British War Building

WARTIME BUILDING CONSTRUCTION—Reprint of official British publications. 151 pp. Chemical Publishing Co., Brooklyn, N. Y. $4.

This book, a reprint of a miscellaneous group of pamphlets issued by the British Government, has little value for American readers except to show how the British are attempting to meet shortages of critical materials and make the most of such materials as are available. Subjects covered include substitution of reinforced concrete for steel, conservation of "shuttering" in reinforced-concrete construction, and conservation of cement and brick in construction operations. There is some information on reinforced-concrete framing for simple one-story buildings and on the layout of one-story factories to simplify construction and save materials. Data on defense construction is limited to a very little on shelters and some diagrams showing how to arrange groups of factory buildings for concealment and to minimize bomb damage.

Miscellaneous Notes on Booklets and Reprints

AIR RAID SHELTERS of heavy-gage corrugated iron are described in a pamphlet entitled "Air Raid Shelters" issued by Armco Drainage Products Assoc., Middleton, Ohio.

SPECIAL ASSESSMENTS are described in a manual of procedures and forms for cities and villages in Wisconsin. Copies, costing $1, can be obtained from the League of Wisconsin Municipalities, 30 E. Johnson St., Madison, Wis.

EMERGENCY STEEL SPECIFICATIONS recently issued by the American Iron and Steel Institute, 350 Fifth Ave., New York, under the title "Simplification of Structural Steel Shapes" (25c.), was erroneously credited to the American Institute of Steel Construction in these pages in the issue of January 29, 1942.

A PROPOSED PLUMBING CODE has been drafted by the American Society of Mechanical Engineers for the American Standards Association and is being distributed to interested parties by T. I. Coe, 29 West 39th St., New York.

TO AID POLICYHOLDERS in providing civilian protection during air raids, the Metropolitan Life Insurance Co., New York, has prepared a 48-pp. booklet "Air-Raid Precautions for Personnel, Plants and Buildings." This publication not only supplies valuable data as to construction features presenting a potential risk, as to the effects of bombing with the various bomb types and the most satisfactory type of shelter, but it also discusses organization of the occupants of a building for protection. Likewise to aid those desiring added information about the many problems in providing civilian protection there is supplied an extensive reference list of books and periodicals dealing with various phases of the subject. Copies of the booklet are obtainable from the company's Policyholders Service Bureau, 1 Madison Ave., New York, N. Y.

THE DEVELOPMENT OF PRESTRESSED CONCRETE, from early experiments of the 1890s down to successful field uses of the present day, is described in a paper by K. Billig in the December, 1941, *Bulletin* of The Institution of Civil Engineers of Ireland. The bulletin is available for 1s. net from the Institution's offices, 35 Dawson St., Dublin, or Fritz Billig, 151-14 85th Ave., Jamaica, L. I., N. Y., has copies of the original paper. The work of Considère, Freyssinet, Dischinger, the author, and others, is covered.

New Engineering Books

AMERICAN HIGHWAY PRACTICE—By I. I. Hewes. 459 pp. John Wiley & Sons, New York; Chapman & Hall, London. $5.

SURVEYING—By Charles B. Breed. 495 pp. John Wiley & Sons, New York; Chapman & Hall, London. Price $3.

SAFETY SUPERVISION—By Vernon G. Schaefer. 352 pp. McGraw-Hill Book Co., New York and London. $2.50.

MODERN BATTLE—By Major Paul W. Thompson. 220 pp. W. W. Norton & Co., New York. $2.75.

PRACTICAL ARC WELDING—By W. J. Chaffee. 516 pp. Hobart Trade School, Inc., Troy, Ohio. Price $2.

ELEMENTARY PLANE SURVEYING—By Raymond E. Davis. Second Edition. 464 pp. McGraw-Hill Book Co., New York and London. Price $3.

SIMPLE BLUEPRINT READING: Special Reference to Welding—146 pp. The Lincoln Electric Co., Cleveland, Ohio. 50c. in U. S. A. 75c. elsewhere.

TRANSPORTATION AND NATIONAL DEFENSE—The Edward Eugene Loomis Foundation, Lafayette College, Lectures 1941, 91 pp. University of Pennsylvania Press, 3622 Locust St., Philadelphia, Pa. Price $1.50.

BUILDING CONSTRUCTION—Second Edition. By Whitney Clark Huntington. 674 pp. John Wiley & Sons, New York; Chapman & Hall, London. Price $6.

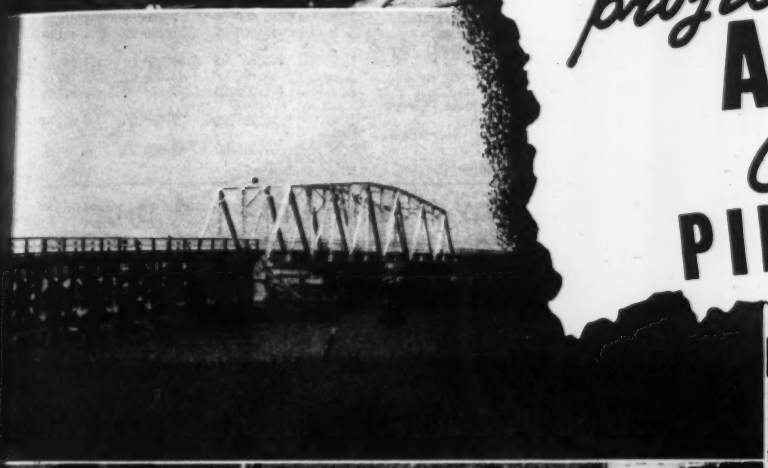
MANUAL OF MOMENT DESIGN — By Jack Singleton. 146 pp. American Institute of Steel Construction. May be obtained from the Institute, 101 Park Ave., New York, or H. M. Ives & Sons, Topeka, Kan. $4.

(*Continued on p. 88*)

MEMO

For Every Construction Job — foundations, bridges, wharves and other timber projects use —

AMCRECO *Creosoted* **PILES** *and* **TIMBER**



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ADDRESS INQUIRIES TO CHICAGO, ILL., OR LOUISVILLE, KY.

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

POWERHOUSE SUPERSTRUCTURE, SURGE TANKS, FORT PECK DAM

OWNER: U. S. Engineer Office, Kansas City, Mo. Harza Engineering Co., Chicago, consulting engineers.

PROJECT: Construction of powerhouse superstructure, penstocks, surge tanks, plate liner and shaft building at Control Shaft No. 1, at Fort Peck, approximately 20 miles southeast of Glasgow, Mont., including installation of turbines, governors and other equipment furnished under another contract. Powerhouse to be located within existing outlet structure for Fort Peck tunnels. Powerhouse superstructure and surge tank structure to be erected on substructure built by others. Area over penstocks and wye branch, between existing tunnel outlet and powerhouse to be covered by concrete slab and earth fill. Outside fenced substation to be built south of powerhouse and existing left outlet structure. Main control shaft building and a steel plate liner to be built at top and bottom, respectively, of existing control shaft. Powerhouse to contain one 50,000 hp. unit, one 20,000 hp. unit, and provision for an additional 50,000 hp. unit.

CONDITIONS: Government to furnish all cement (except white and special cements), sand, gravel, waterproofing and curing solutions, and water. Contractor to furnish remainder of material, and complete all work by June 30, 1944. An escalator clause provides for adjustment in prices for labor and material based on Bureau of Labor Statistics data on average hourly construction labor earnings, and wholesale material prices. Labor to be accepted as 30 percent of contract price; material, 40 percent. Extremes in temperatures may be encountered. Rail and highway transportation facilities available. Wage rates are: skilled labor, $1.00 to $1.20 per hr.; semi-skilled, 65 to 80c.; and common, 50 to 60c.

BIDS: Four bids were received December 12, 1941, ranging from the contract low of $3,407,026 to $3,790,400. Engineer's estimate, $3,011,766.

LIST OF BIDDERS:

1. Fegles Constr. Co., Ltd., Minneapolis, Minn. (contract) $3,407,026
2. O'Driscoll & Grove, Inc., New York, N. Y. 3,433,691
3. Woods Bros. Constr. Co., Omaha, Nebr. 3,457,020
4. Morrison-Knudsen Co., Inc., Little Rock, Ark. 3,790,400

Item	Quan.	Unit Prices (1)	(2)	(3)
1. General earth excavation	1,700 c.y.	$1.50	$0.62	$1.20
2. Trench and fndn. excav. (earth)	2,100 c.y.	2.50	.75	2.30
3. Excavation of shale	270 c.y.	4.50	31.00	5.40
4. Break and remove exist. concrete	370 c.y.	32.00	56.00	65.00
5. Place gravel backfill	2,270 c.y.	3.00	1.37	.70
6. Furn. and place plain backfill	41,000 c.y.	1.00	1.05	.90
7. Place gravel top course	L. S.	3,000.00	3,800.00	1,095.00
8. Furn. and place vitr. pipe drain tile	L. S.	1,090.00	1,100.00	1,860.00
9. Furn. and lay transformer transfer track	L. S.	10,000.00	5,900.00	5,968.00
10. Furn., install substation fence	L. S.	5,000.00	2,600.00	2,290.00
11. Place concrete floor finish	L. S.	3,000.00	9,800.00	6,236.00
12. Place ground concrete floor finish	L. S.	2,000.00	3,200.00	2,668.00
13. Furn. and apply floor hardener trtmt.	L. S.	2,000.00	750.00	1,634.00
14. Furn., place reinforcing steel	1,510,000 lb.	.096	.09	.08
15. Drill dowel bar holes; place bars	440 l. f.	5.00	2.00	.50
16. Copper water stops	L. S.	500.00	300.00	465.00
17. Joint filler	L. S.	2,000.00	7,400.00	806.00
18. Clay tiles for joist construction	L. S.	500.00	350.00	520.00
19. Concrete sidewalks	L. S.	800.00	500.00	1,820.00
20. Grout pipes and connections	200 lb.	3.00	.62	.50
21. Pressure grouting	100 c. f.	10.00	2.50	6.20
22. Mix and place plain grout	L. S.	4,000.00	1,800.00	620.00
23. Furn. and place metal reglets	L. S.	2,100.00	2,800.00	2,600.00
24. Class A concrete, powerhouse	15,740 c. y.	32.00	36.25	46.00
25. Class C concrete, powerhouse	10 c. y.	40.00	55.00	45.00
26. Class E concrete, powerhouse	17 c. y.	12.00	30.00	14.00
27. Membrane waterproofing	L. S.	5,500.00	6,800.00	6,000.00
28. Furn. and install damp-proofing	L. S.	700.00	900.00	770.00
29. Furn., erect structural steel	L. S.	142,000.00	114,000.00	173,152.00
30. Misc. steel and metalwork	L. S.	45,000.00	33,200.00	36,000.00
31. Furn., erect penstocks, surge tanks and tunnel lining, and install butterfly valves	L. S.	1,410,000.00	1,410,116.00	1,201,750.00
32. Furn., place ornamental metal work	L. S.	5,000.00	6,800.00	8,975.00
33. Furn., place doors and frames	L. S.	17,500.00	25,000.00	18,650.00
34. Furn., place tile furring and partitions	L. S.	5,600.00	8,000.00	8,676.00
35. Furn., place metal lath and plaster	L. S.	20,000.00	23,000.00	19,950.00
36. Furn., install spec. floor finish and wainscot	L. S.	16,000.00	18,000.00	14,340.00
37. Furn., install rough carpentry	L. S.	3,300.00	11,000.00	4,420.00
38. Furn., install caulking	L. S.	400.00	625.00	2,650.00
39. Furn., place 1-in. board insulation	L. S.	6,000.00	11,700.00	12,520.00
40. Furn., place built-up insulation	L. S.	5,100.00	6,200.00	2,235.00
41. Furn., install metal deck floor	L. S.	800.00	600.00	2,990.00
42. Steel lockers	L. S.	200.00	200.00	125.00
43. Glass block walls, glass, mirrors and shelves	L. S.	7,600.00	11,000.00	13,970.00
44. Asbestos cement partitions, doors and flues	L. S.	10,000.00	12,000.00	19,120.00
45. Furnish finish hardware	L. S.	2,600.00	3,800.00	3,880.00
46. Furnish roofs, roofing and copper metal work	L. S.	32,000.00	28,200.00	23,900.00
47. Furn., install cast stone surge tank housing	L. S.	75,000.00	68,000.00	89,000.00
48. Assemble, install turbines, governors	L. S.	24,000.00	11,400.00	13,000.00
49. Furn. and place hydraulic control boards, meters and gages	L. S.	5,100.00	5,000.00	9,250.00
50. Furn., erect powerhouse crane	L. S.	77,000.00	77,500.00	104,000.00
51. Furn., place 12-ton electr. hoist	L. S.	4,000.00	5,000.00	4,560.00
52. Furn., erect stop log gantry crane	L. S.	9,000.00	10,600.00	7,460.00
53. Furn. transformer transfer car	L. S.	2,000.00	1,000.00	1,125.00
54. Furn., install elevators	L. S.	30,000.00	31,200.00	25,730.00
55. Inst. transformer room crane	L. S.	2,000.00	3,100.00	3,644.00
56. Furn. and apply field paints	L. S.	15,000.00	31,200.00	4,690.00
57. Furn., install plumbing and piping	L. S.	112,000.00	150,000.00	131,970.00
58. Heating and ventilating system	L. S.	56,000.00	44,000.00	39,140.00
59. Furn., install electrical work	L. S.	441,500.00	380,277.00	426,926.00
60. Alterations to Main Control Shaft No. 1	L. S.	15,937.00	7,000.00	7,385.00
61. Buildings for Main Control Shaft No. 1	L. S.	50,000.00	48,800.00	48,580.00

HIGHWAY IMPROVEMENTS, OHIO

OWNER: Ohio State Highway Department, Columbus, Ohio.

PROJECT: Grading, drainage structures, concrete box culverts, bridge, roadside improvement, and reinforced concrete paving 9.092 miles of highway in Montgomery County, Ohio. Sections to be improved, F (pt.) and G, are on direct north and south highway near Dayton, U. S. Route 25, which carries heavy defense traffic from Toledo and Detroit. Portion of construction is two pavements of 24-ft. each, and portion to be from 46 to 51-ft. wide.

CONDITIONS: Contractor to furnish all materials and complete work by December 31, 1942. Rail and highway transportation facilities available. Wage rates are: skilled labor, $1.25 to $1.75 per hr.; semi-skilled, 87¢ to $1.25; and common, 70¢.

BIDS: Four bids were received December 16, 1941, ranging from the contract low of $1,217,716 to $1,327,206. Engineer's estimate, $1,267,000.

LIST OF BIDDERS:

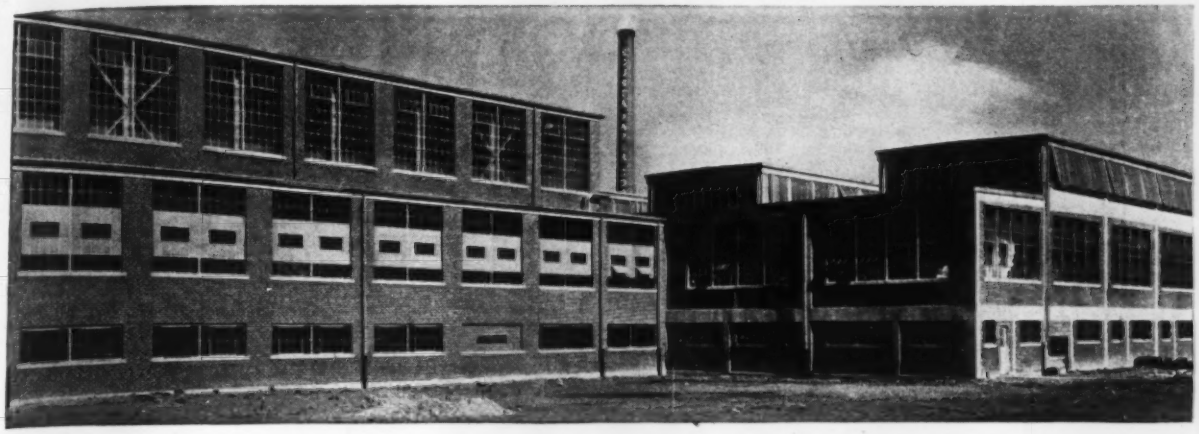
1. Carl Myers & Pierce Constr. Co. Toledo, Ohio (contract $1,217,716
2. Contractors Finance Corp., Cincinnati, Ohio 1,225,520
3. White Consolidated, Inc., Chicago, Ill 1,317,001
4. A. J. Baltes, Norwalk, Ohio 1,327,206

Roadway

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Roadway excavation, unclassified	635,455 c. y.	$0.30	$0.34	$0.33
2. Borrow (contractor to furnish)	14,411 c. y.	.30	.45	.40
3. Remove, dispose exist. conc. pavmt	1,047 s. y.	.35	.35	.25
4. Remove, dispose exist. conc. base	9,072 s. y.	.35	.35	.25
5. Remove for re-use exist. brick wear. surf	10,899 s. y.	.20	.30	.50

AMERICA 'ROLLS ITS OWN'

CIGARETTE-PAPER PLANT CAPACITY DOUBLED



'INCOR' PREVENTS COLD-WEATHER SLOW-DOWN

QUALITY PAYS. . .
INSIST ON LONE STAR
AND 'INCOR'

TWO big factories of Ecusta Paper Corporation, on a 225-acre site at Pisgah Forest, N. C., supply much of the nation's cigarette-paper requirements. No sooner was the first plant completed, in June 1940, than construction of the second plant began, to replace imported paper, shut off by war.

In the first plant, 'Incor' was used for watertight concrete... early strength in concrete-frame erection... heavy-duty floors and machinery foundations. Results speak for themselves . . . 'Incor' was used for the same purposes in the second plant as well.

It gets cold and stays cold in that part of the South—so 'Incor' also provided an important cold-weather safety factor.

Speed defense construction . . . prevent cold-weather slow-downs. Use 'Incor'* for dependable high early strength plus long-time durability. Write for copy of "Cold-Weather Concreting." Lone Star Cement Corporation, Room 2286, 342 Madison Avenue, New York.

*Reg. U. S. Pat. Off.

LONE STAR CEMENT CORPORATION

Offices: ALBANY • BIRMINGHAM • BOSTON • CHICAGO • DALLAS • HOUSTON • INDIANAPOLIS • KANSAS CITY • NEW ORLEANS • NEW YORK • NORFOLK • PHILADELPHIA • ST. LOUIS • WASHINGTON, D. C.

6. Remove exist. conc. curb and gutter..	6,198 l. f.	.15	.10	.15
7. Water (estimated)	3,655 M gal.	1.25	2.00	3.00
8. Remove, dispose 4- to 24-in. pipe	1,443 l. f.	.50	.25	.45
9. Remove, store 8- to 15-in. corr. met. pipe	283 l. f.	.50	.40	.72
10. Remove, store 30-in. corr. met. pipe..	97 l. f.	1.00	.60	1.35
11. Remove and store 12-in. ci. pipe	16 l. f.	.75	1.00	1.35
12. Remove for re-use 36-in. pipe	181 l. f.	1.00	1.00	1.80
13. Remove for re-use 60-in. pipe	264 l. f.	2.50	3.00	3.60
14. 8-in. corr. metal pipe, for driveways..	24 l. f.	1.25	1.25	.90
15. 12-in. corr. metal pipe, for driveways.	134 l. f.	1.64	1.50	1.20
16. 15-in. corr. metal pipe, for driveways.	52 l. f.	2.00	2.00	1.40
17. 18-in. corr. metal pipe, for driveways.	26 l. f.	2.30	2.50	1.80
18. 30-in. corr. metal pipe, for driveways.	36 l. f.	4.20	4.50	3.60
19. 54-in. corr. metal pipe, for driveways.	124 l. f.	9.25	9.00	9.00
20. 37x21-in. corr. met. arch with integral base	30 l. f.	8.25	10.00	5.40
21. 6-in. plain cem. conc. pipe, storm sewers	10 l. f.	.95	.50	9.00
22. 12-in. as above	1,889 l. f.	1.15	.90	1.15
23. 15-in. as above	908 l. f.	1.70	1.15	1.40
24. 18-in. as above	1,891 l. f.	2.00	1.75	2.00
25. 24-in. as above	3,807 l. f.	2.50	2.40	2.90
26. 30-in. rein. conc. pipe, storm sewers..	357 l. f.	4.10	5.00	4.00
27. 10-in. rein. con. pipe, storm sew. under pavmt	76 l. f.	1.50	1.40	1.60
28. 12-in. as above	2,819 l. f.	1.55	1.50	1.80
29. 15-in. as above	1,431 l. f.	2.25	1.75	2.15
30. 18-in. as above	529 l. f.	2.45	2.25	2.50
31. 24-in. as above	641 l. f.	3.20	3.50	3.35
32. 30-in. as above	230 l. f.	4.35	4.50	4.50
33. 36-in. as above	14 l. f.	5.50	6.00	5.85
34. 60-in. as above	1,182 l. f.	13.00	14.00	13.50
35. 60-in. rein. conc. pipe, storm sewers under pavmt., spec. joints	102 l. f.	14.00	16.00	15.75
36. 8-in. pl. cem. conc. pipe, storm sew., bottom half sealed only, porous bkfill	357 l. f.	1.00	.80	1.15
37. 10-in. as above	255 l. f.	1.10	1.00	1.45
38. 12-in. as above	675 l. f.	1.35	1.15	1.60
39. 15-in. as above	426 l. f.	1.80	1.50	2.00
40. 18-in. as above	349 l. f.	2.05	1.80	2.70
41. 10-in. rein. conc. pipe, storm sew., bottom half sealed only, porous bkfill..	20 l. f.	1.60	1.50	2.00
42. 15-in. as above	6 l. f.	2.35	2.50	2.70
43. 18-in. as above	10 l. f.	2.55	3.00	3.40
44. 6-in. ext. qual. drain tile, or p. c. c. pipe for roadway drainage	4,032 l. f.	.90	.45	.65
45. 12-in. b. and s. pl. cem. conc. pipe, rd. dr	388 l. f.	1.35	.75	1.35
46. 6-in. ex. qual. dr. tile, or p. c. c. pipe, underdrain	31,291 l. f.	.90	.60	.90
47. 6-in. b. and s. rein. conc. pipe, pvmt. underdr	1,143 l. f.	1.20	1.00	1.58
48. 6-in. 45-deg. bend pipe spec	20 ea.	3.00	2.50	2.25
49. 6-in. 90-deg. bend pipe spec	21 ea.	3.00	3.00	2.25
50. 6x6-in. wye pipe special	1 ea.	3.00	5.00	2.25
51. 24x15-in. wye pipe special	1 ea.	18.00	25.00	18.00
52. 60x12-in. tee pipe special	3 ea.	75.00	80.00	81.00
53. 36-in. pipe relaid with spec. joint	169 l. f.	1.65	2.00	3.60
54. 60-in. pipe relaid with spec. joint	240 l. f.	4.00	3.00	7.20
55. Std. No. 3 manholes	22 ea.	350.00	200.00	225.00
56. Special manhole	1 ea.	550.00	400.00	250.00
57. Standard No. 1 manholes	20 ea.	185.00	150.00	135.00
58. Std. No. 2 manholes, without drops..	2 ea.	250.00	200.00	180.00
59. Std. No. 1–2 catch basins, modified..	89 ea.	60.00	40.00	54.00
60. Standard No. 2–2 catch basins	2 ea.	50.00	40.00	63.00
61. Std. No. 1–3 catch basin, modified...	3 ea.	80.00	80.00	67.50
62. Std. No. 1–3 catch basin	1 ea.	70.00	75.00	67.50
63. Std. No. 3 catch basins	49 ea.	150.00	100.00	135.00
64. Std. No. 3-A catch basins	1 ea.	150.00	150.00	125.00
65. Std. No. 1 side ditch inlets	3 ea.	30.00	35.00	45.00
66. Reset manhole castings to grade	8 ea.	5.00	5.00	25.00
67. 12-in. type A riprap	53 s. y.	4.00	4.00	2.75
68. 4-in. conc. sidewalks (1 crse. const.)..	21,988 s. f.	.25	.25	.17
69. Conc. steps, 6-in. riser, 18-in. tread..	13.5 l. f.	2.50	1.50	5.00
70. Conc. steps, 7-in. riser, 15½-in. tread.	6 l. f.	2.50	1.50	9.00
71. Conc. steps, 5-in. riser, 15-in. tread..	21 l. f.	1.75	1.50	4.00
72. Conc. steps, 4-in. riser, 12-in. tread..	16 l. f.	1.00	1.50	4.00
73. Paved gutter, type 3	326.5 l. f.	3.00	2.00	.60
74. Paved gutter, special	974 l. f.	1.25	3.00	1.14
75. Guard rail, std. str. flexible steel plate tens. type	14,832 l. f.	1.00	1.00	.80
76. Guard rail, multiple-cable type	4,592 l. f.	.82	1.25	.80
77. Remove and store guard rail	557 l. f.	.20	.30	.50
78. Remove and rebuild guard rail	56 l. f.	.60	.80	1.00
79. Seed and protect roadway areas	606,096 s. y.	.04	.035	.05
80. Classified embank. mat'l (blanket course)	64,184 c. y.	.60	.50	.75
81. Abandon exist. manholes, catch basins, inlets	36 ea.	15.00	15.00	3.35
82. 6-in. concrete revetment	314.6 s. y.	2.75	3.00	2.50
83. Fence	62,331.8 l. f.	.24	.25	.20
84. Traffic bound surf. crse., temp. rdway.	600 ton	2.00	2.00	3.50
85. Traffic compacted surf. crse	850 c. y.	2.25	2.00	4.00
86. Calcium chloride, temp. roadway	8 ton	30.00	40.00	40.00

Roadside Improvement

Item	Quan.	Unit Prices (1)	(2)	(3)
87. Riprap for tree protection (stone)	420 s. y.	4.00	3.00	2.50
88. Aggregate for tree root aeration	570 c. y.	2.00	2.25	2.00
89. Commercial fertilizer (4–12–4)	113,809 lb.	.02	.03	.02
90. Sodding	26,175 s. y.	.25	.25	.28
91. Hall Japanese Honeysuckle (2 yr.)	5,587 ea.	.25	.50	.50
92. Chinese Matrimony vine (2 to 3-ft.)..	2,128 ea.	.30	.50	.75
93. Bigleaf Wintercreeper (18 to 24-in.)..	214 ea.	1.00	1.25	1.50
94. Glossy Wintercreeper (18 to 24-in.)...	372 ea.	.95	.80	2.00
95. Spreading Euonymus (18 to 24-in.)...	59 ea.	1.00	1.00	2.25
96. Japanese Barberry (2 to 3-ft.)	198 ea.	.75	1.00	1.25
97. Japanese Barberry (18–24-in., hvy.)..	1,850 ea.	.80	.75	1.00
98. Meintor Barberry (18 to 24-in.)	438 ea.	.80	1.00	2.00
99. Slender Deutsia (18 to 24-in.)	240 ea.	.75	1.00	1.50
100. Winged Dwarf Euonymus (18–24-in.).	51 ea.	.90	2.50	1.75
101. Thunberg Spiraea (2 to 3-ft.)	91 ea.	.80	1.00	1.25
102. Regel Privet (3 to 4-ft.)	77 ea.	1.00	1.25	1.50
103. Meadow Rose (18 to 24-in.)	102 ea.	.75	.75	1.25
104. Bristly Rose (18 to 24-in)	67 ea.	.80	.75	1.25
105. Five-leaved Aralia (3 to 4-ft.)	60 ea.	.90	1.00	1.50
106. Arrowood (4 to 5-ft.)	23 ea.	1.20	1.25	2.00
107. American or White Ash (2 to 2½-in. cal.)	21 ea.	9.00	12.00	8.00
108. American Planestree (2 to 2½-in. caliper)	33 ea.	10.00	12.00	8.00
109. American Linden (2 to 2½-in. caliper)	33 ea.	10.00	15.00	7.50
110. Austrian Pine (8 to 10-ft.) balled, burlapped	24 ea.	15.00	20.00	20.00
111. Mulching (straw)	26,175 s. y.	.02	.03	.01

Pavement

Item	Quan.	Unit Prices (1)	(2)	(3)
112. 6-in. portland cem. conc. base crse	286.7 s. y.	2.00	1.50	1.80
113. 7-in. rein. port. cem. conc. base crse..	638.9 s. y.	2.15	1.75	2.10
114. Coarse aggr. for waterbound mac. base course	832 ton	3.50	2.00	2.00
115. Screenings, waterbd. mac. base crse..	305 ton	3.50	2.00	2.00
116. 4½-in. min. thickness port. cem. conc. base course	68.8 c. y.	10.00	12.00	11.00
117. Aggregate, surf. trtmt.: No. 46	124 ton	3.50	2.00	4.50
118. Bitum. matl. for seal coat	1,397 gal.	.20	.20	.15
119. Bitum. matl. for prime coat	1,956 gal.	.20	.20	.15
120. Surf. trtmt. bitum. material	3,351 gal.	.20	.20	.15
121. 9–7–7–9-in. port. cem. conc. pavmt...	6,519.6 s. y.	2.00	1.70	2.00
122. 9–6–6–9-in. port cem. conc. pavmt...	14,874.4 s. y.	1.90	1.60	1.91
123. 6-in. port. cem. conc. pavmt	1,284 s. y.	1.90	1.50	1.90
124. 9–7–7–9-in. rein. port. cem. conc. pav.	205,039.5 s. y.	2.00	1.95	2.17
125. 9–7–7–9-in. red. rein. port. cem. conc. pavmt	61,573.4 s. y.	2.15	2.20	2.30
126. 5-in. min. thick. rein. port. cem. conc. pavmt	471.1 c. y.	10.00	12.00	11.00
127. As above, red	32 c. y.	14.00	12.00	15.00
128. Salvage brick wearing surface	1,374.3 s. y.	1.20	.75	2.00
129. 12x4-in. flush conc. curb	64.07 l. f.	.40	1.00	1.00
130. Type 4-A concrete curb	32,746.1 l. f.	.25	.20	.15
131. Type 4-B concrete curb	619.86 l. f.	.50	1.00	.15
132. Type D conc. curb, incl. dowels	45 l. f.	1.00	1.25	1.00
133. Traffic bound side approaches	967 c. y.	2.50	2.25	5.00
134. Bitum. matl. for bitum. trtmt. of rigid pavmt	463 s. y.	.10	1.00	.05
135. No. 6 aggr. for bitum. trting. rigid pavt	13 c. y.	2.50	3.00	3.50
136. No. 6 aggr. for surf. trtmt. (choke and cover aggr.)	49 ton	3.50	2.50	3.00

Structures—20-ft. Span and Under

Item	Quan.	Unit Prices (1)	(2)	(3)
137. Excav. for structures (unclassified)...	4,934 c. y.	2.00	1.25	1.50
138. Channel excavation	3,078 c. y.	.75	.50	.80
139. Cl. C conc.: structures and pluggine pipe	1,663 c. y.	27.00	22.00	25.50
140. Class G conc. for structures	12.3 c. y.	30.00	20.00	25.50
141. Waterproofing, type B	519 s. y.	1.50	1.00	1.20
142. Reinforcing steel	191,360 lb.	.06	.06	.058
143. ¼-in. bitum. premolded exp. joint filler	240 s. f.	.25	.30	.15
144. 12-in. 24-oz. folded copper strip	219 l. f.	1.00	1.00	1.55
145. Remove portion of exist. structures..	L.S.	100.00	500.00	900.00
146. Dowel holes, 1¾x4-in	14 ea.	1.00	1.00	.90
147. Remove existing structures	L.S.	1,300.00	500.00	350.00
148. 6-in. rein. conc. pipe: rdway. culverts	233 l. f.	1.05	1.10	1.10
149. 12-in. rein. conc. pipe: rdway. culverts	182 l. f.	1.25	1.50	2.00
150. 15-in. rein. conc. pipe: rdway. culverts	1,802 l. f.	2.00	1.75	2.50
151. 18-in. rein. conc. pipe: rdway. culverts	769 l. f.	2.25	2.25	2.90
152. 24-in. rein. conc. pipe: rdway. culverts	1,150 l. f.	3.00	3.50	4.50
153. 30-in. rein. conc. pipe: rdway. culverts	747 l. f.	4.25	4.25	6.00
154. 36-in. rein. conc. pipe: rdway. culverts	166 l. f.	5.50	5.50	8.15
155. 60-in. rein. conc. pipe: rdway. culverts	181 l. f.	13.00	14.00	17.00
156. 66-in. rein. conc. pipe: rdway. culverts	400 l. f.	15.00	16.00	20.00
157. 36-in. ext. str. rein. conc. pipe, rdway. culv	232 l. f.	5.85	5.50	10.15
158. 42-in. ext. str. rein. conc. pipe, rdway. culv	220 l. f.	7.50	8.00	12.00
159. 60-in. ext. str. rein. conc. pipe, rdway. culv	195 l. f.	14.00	15.00	21.35
160. 12-in. paved. but. coat. c. m. pipe, rdway. culv	18 l. f.	2.00	2.50	2.40
161. 15x12-in. tee pipe special	1 ea.	11.00	10.00	14.50
162. 18x12-in. tee pipe special	2 ea.	11.00	10.00	16.00
163. 24x12-in. tee pipe special	4 ea.	18.00	10.00	27.00
164. 30x12-in. tee pipe special	1 ea.	30.00	15.00	36.00
165. 36x12-in. tee pipe special	1 ea.	32.00	20.00	38.50
166. 60x12-in. tee pipe special	1 ea.	100.00	75.00	100.00
167. 66x12-in. tee pipe special	1 ea.	150.00	75.00	168.00
168. 42x12-in. ex. str. tee pipe special	1 ea.	50.00	50.00	74.00
169. 60x12-in. ex. str. tee pipe special	1 ea.	110.00	80.00	129.00
170. ¾x13-in. expan. anchor bolts	14 ea.	1.25	1.00	2.40
171. 24-in. Calco automatic headgate	1 ea.	50.00	100.00	37.00

Structures—Over 20-ft. Span

Item	Quan.	Unit Prices (1)	(2)	(3)
172. Cofferdams and pumping	L.S.	300.00	2,500.00	2,200.00
173. Uncl. excavation, structures	455 c. y.	2.00	1.50	2.00
174. Channel excavation	2,642 c. y.	.75	.50	.90
175. Class C concrete, culvert	978 c. y.	22.00	22.00	21.60
176. Class C concrete, apron	37 c. y.	15.00	15.00	16.90
177. Type C waterproofing	71 s. y.	1.00	2.00	.50
178. Reinforcing steel (6x6-in. No. 4 gage welded wire mesh)	870 lb.	.10	.06	.06
179. Reinforcing steel	270,390 lb.	.06	.06	.058
180. Steel sheets, 18-gage	774 lb.	.25	.10	.15
181. Riprap	140 s. y.	3.00	3.00	3.00
182. Premium on industrial insurance	L.S.	10,000.00	38,000.00	15,000.00
183. Maintain traffic, incl. lights, signs, barricades and watchmen	L.S.	3,000.00	5,000.00	5,000.00

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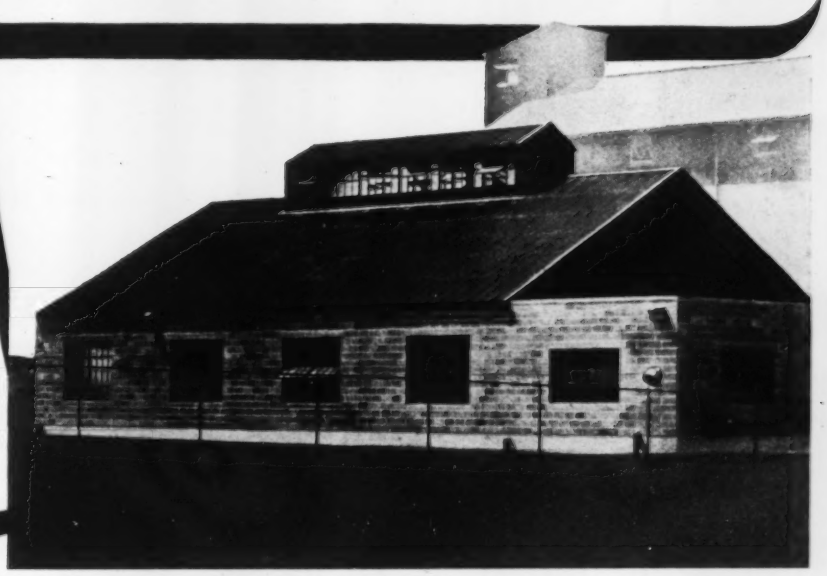

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Choose the right

and

Choosing the right materials for any job—and treating them right on the job—is always sound judgment. Today with acute and growing shortages in construction equipment and materials, it's more than ever the part of wisdom for contractors to select materials and equipment that represent sound value and to handle them in the way that will insure the best and longest service.

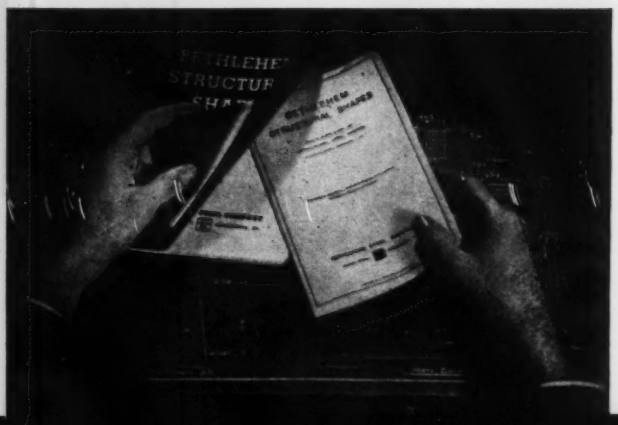
Square ends lengthen drill-steel life

Here's a suggestion that will help you to get the last ounce of service out of every length of hollow drill steel. When you cut off a drill rod in preparation for forging, cut both ends absolutely square. A satisfactory bit can't be forged from an irregular or unevenly-cut face; the wings would be uneven in length and laps might be formed. The face of the shank end must also be square. If it isn't, the drill will fail before its time and the hammer may be seriously damaged.

Bethlehem Superior Hollow Drill Steel has plenty of guts. It's made of a tough, specially-developed steel. The hole is accurately centered. Smooth inner walls are free from pits that might give fatigue stresses a foothold. It is pre-tested for hardenability to insure simple, economical heat treatment on the job. Bethlehem Superior Hollow Drill Steel is made in standard sections in lengths up to 42 ft.

Reinforcing steel cut—formed—fabricated to your needs

With contractors facing a huge job of constructing facilities for the production of war materials, Bethlehem's reinforcing steel warehouses in fifteen major construction areas are more important than ever to the building industry. In addition to carrying reinforcing bars in standard sizes, each Bethlehem warehouse has a shop fully equipped to cut, form and fabricate reinforcing steel to your requirements. Bethlehem also makes a complete line of bar supports, chairs, spacers and accessories needed for any kind of reinforced concrete construction work.



Have you a copy of the simplified list of Structurals?

Since February 1, the production of many structural sections formerly rolled has been eliminated in the interests of simplified production and conservation of steel. The simplified range of structural shapes may make necessary certain engineering changes and substitutions. Be sure you have this information at your finger tips. Write Bethlehem Steel Company, Bethlehem, Pa., for a copy of the booklet that lists the new, simplified range of Bethlehem Structural Shapes.

ht materials...

d treat 'em right

How to lengthen wire-rope life

Wire rope is really a precision machine. As such, it deserves the same care you'd give any fine piece of machinery. By following these three simple suggestions, you'll not only get the best service out of Bethlehem Wire Rope, you'll make it last longer:

1. Inspect, clean and lubricate all rope regularly. Keep fittings tight and be sure the hemp core is not dry.
2. Be sure the rope fits sheave or drum grooves. Too large a rope or worn grooves cause pinching and rapid wear, while sheaves and drums that are too small cause rope fatigue.
3. If the rope deviates from the center plane of the sheave more than $1\frac{1}{2}$ deg., undue wear will result. For this reason keep sheaves aligned, bearings tight and properly lubricated and prevent rope slippage on the sheaves.

Above all, be sure the rope you select is the proper one for the job. Bethlehem makes a wire rope that will give maximum service on any construction project. Six grades of steel, three types of cores, all constructions and sizes, are available. For detailed information on choosing the right rope for contractors' and excavating equipment, ask the nearest Bethlehem Wire Rope distributor, or write to Bethlehem Steel Company, Bethlehem, Pa.

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DRIVING
PILES
FASTER AND
AT LESS COST

SUPER-VULCAN
OPEN TYPE
DIFFERENTIAL-ACTING
PILE HAMMER
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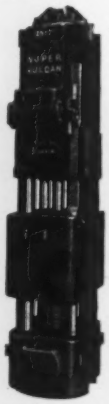
Speed and more speed in construction today—proper tools in the hands of construction men is the thing . . . the Super-Vulcan on the job gets those piles driven in shortest time . . . at worthwhile cost savings.

You get more penetration of each pile per minute all the way down—twice the blows per minute does it. ONE QUARTER to more than ONE THIRD the steam used per blow. Rugged strength, positive action, compactness all are points to consider. The open type fits the same leads and uses the same accessories as the Vulcan Single-Acting Pile Hammers.



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New Engineering Books

(*Continued from p. 80*)

ENGINEERING SURVEYS: ELEMENTARY AND APPLIED—By H. Rubey, G. E. Lommel & M. W. Todd. Text, 664 pp.; Tables 170 pp. The Macmillan Company, New York. $4.50.

WAGE INCENTIVE METHODS—By Charles Walter Lytle. 462 pp. Revised Edition. The Donald Press, New York. $6.

WARTIME BUILDING CONSTRUCTION—Reprint of official British publications. 151 pp. Chemical Publishing Co., Brooklyn, N. Y. $4.

AERIAL BOMBARDMENT PROTECTION—By Harold E. Wessman and William A. Rose. 372 pp. John Wiley & Sons, New York; Chapman & Hall, London. $4.

HIGHWAY ECONOMICS—By Harry Tucker and Marc C. Leager. 454 pp. International Textbook Co., Scranton, Pa. $4.

HYDRAULICS—By George E. Russell, 5th Edition. 468 pp. Henry Holt and Co., New York. $4.25.

The price of THROUGH ENGINEERING EYES (Pitman Publishing Corp., New York) is $1, not $1.50, as stated in these pages recently.

Reports and Pamphlets

AIR RAID WARNING SYSTEM—Office of Civilian Defense, Washington, D. C.

FINANCIAL STATISTICS OF CITIES—1938—U. S. Dept. of Commerce, Bureau of the Census. Price 75c. From the Superintendent of Documents, Washington, D. C.

HIGHWAY TRANSPORTATION FEEDS THE NATION IN DEFENSE—National Highway Users Conference, Washington, D. C.

BUILDING MATERIALS AND STRUCTURES—Report BMS 76, Effect of Outdoor Exposure on the Water Permeability of Masonry Walls. For sale by the Superintendent of Documents, Washington, D. C. 15c.

MILWAUKEE'S PROGRESS IN 1940—Annual Consolidated Report of the Common Council as compiled and edited by the Municipal Reference Library.

BRIDGE RAILINGS THEIR DESIGN AND CONSTRUCTION—Bulletin No. 176, American Institute of Steel Construction, New York.

PROPORTIONING CONCRETE MIXTURES—Circular 21, National Sand and Gravel Association, Munsey Bldg., Washington, D. C. Limited distribution.

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★ ★ ★ ★ CHICAGO PNEUMATIC NEWS ★ ★ ★ ★

LOW MAINTENANCE COST FEATURE OF CP VIBRATORS

↑ **TOPPING TIME: 2 MINUTES!** Here are eight yards of concrete and four men with two CP-518 Vibrators. The second picture was taken two minutes later. Note the concrete is topped off — a typical performance with the CP-518, a two-man vibrator for concrete batches of 2 cubic yards or more; ideal for knocking down and compacting heavy, harshest concrete in open forms — gravity dams, large bridge piers, mats, etc.

1.7 MILLS PER CUBIC YARD TYPICAL REPAIR PARTS COST

Used on Many Large Dam Jobs

NEW YORK — On practically every outstanding construction project—Grand Coulee, Marshall Ford, Ruby, Friant, Shasta and Hansen Dams, Baton Rouge Bridge, Delaware River Aqueduct — Chicago Pneumatic Concrete Vibrators have shown remarkably low maintenance costs. A typical record is that made on one large dam job: four CP-518 Vibrators placed a total of 312,000 cubic yards of concrete—approximately 75,000 cubic yards per vibrator — at a cost for repair parts of 1.7 mills per cubic yard. Complete data on the seven models of CP Concrete Vibrators, Pneumatic and Electric, will be forwarded upon request.

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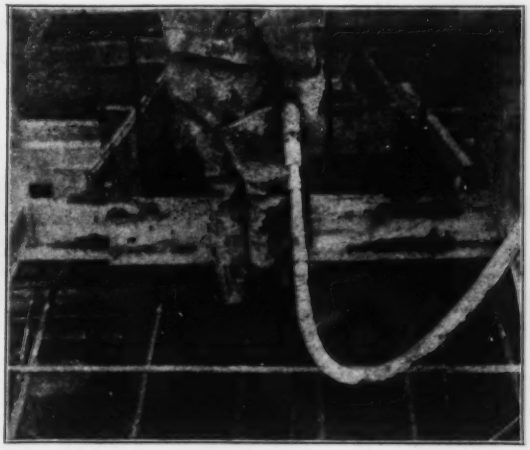
↑ **FOR LIGHT REINFORCED CONCRETE SECTIONS,** 3" slump and over, there is no vibrator faster or cheaper to operate than the CP-219. For walls and columns under 15" thick, light floor and roof slabs.

← **FLUSHING MORTAR** to the face of vertical key is an easy, speedy job with CP-419 Hicycle Electric Vibrator. For batches of mass concrete up to two cubic yards; medium bridge piers, mats, etc.



↑ **PLACING CONCRETE IN LOCK FOUNDATION,** CP-325 Concrete Vibrator. For concretes under 3" slump; walls and columns over 15" thick; heavy floor and roof slabs; appurtenances on heavy construction jobs. Especially designed for hard service.

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ALL over the world SAUERMAN Slackline Cableways, Power Drag Scrapers and Tower Excavators are proving their economy in excavating, loading, stockpiling and long range material-handling in general.

A SAUERMAN machine can operate on a lake shore or in a river, on mushy ground, on a hillside, or in a rough pit. The bucket will penetrate the hardest packed material, gather a heaping load quickly, then haul its load at high speed to a bin, hopper or storage pile.

Digging, hauling and automatic dumping are merged into a continuous operation controlled by one operator. Power requirement is moderate. Maintenance is simple because the wearing parts are few and all easily accessible.

The sizes of SAUERMAN machines range from a light, portable unit with a 200-ft. operating span, rated to handle 20 cu. yd. per hour, up to a big, powerful machine which has an operating span of 1500 ft. and is equipped with a 15 cu. yd. scraper bucket.

Write for catalog.

Sauerman Cableway spans a culm pile 1,000 ft. wide and reclaims the culm to hopper on top of briquet plant at cost of less than 4c per ton.

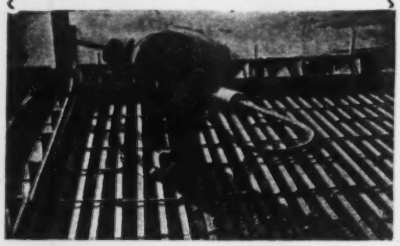
Sauerman Scraper hauls sand from hill to feed two asphalt mixing plants. One man runs the machine. Fuel cost is 40c per hour.

SAUERMAN BROS., Inc.

532 S. Clinton St. Chicago, Illinois

VIBER COMPANY CONCRETE

VIBRATION



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When the job calls for mass vibration—the Viber Vibrator at work above is your best bet. Especially made for walls over 10 inches thick, foundations, large girders, thick floor slabs, columns . . . large reinforced concrete bridges, grade separations, concrete floor systems, concrete arches and rigid frame structures . . . in a word, for all concrete with large aggregate and low water-cement ratio.

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MEN AND JOBS

H. N. Baker, formerly of the San Juan, P. R. office of the Federal Works Agency, has been transferred to the Work Projects Administration office at Washington, D. C.

Charles L. Wartelle, city engineer of Seattle, Wash., has been reappointed to that position by Mayor Earl Millikin. **Eugene R. Hoffman,** lighting superintendent at Seattle, has also been reappointed.

M. W. Tatlock, superintendent of the Dayton, Ohio, sewage treatment plant, has taken a six-month leave of absence to become assistant chief engineer on the construction of a $40,000,000 Army camp near Indianapolis, Ind. Mr. Tatlock will supervise a staff of 600 engineers and inspectors for the Charles H. Hurd Co., consulting engineers and architects.

M. C. Shibley, northeastern Oklahoma division engineer for the Oklahoma highway department, has been appointed by the Tulsa County Commission as a consulting engineer on a $560,000 construction program to provide access roads to one of the large war factories in the Tulsa area. He was granted a leave of absence from the highway department for the duration of the work.

Guy V. Keeler, director of the engineering-science-management-defense training program at the University of Kansas, has been appointed by the National Safety Council as coordinator for educational class work in safety engineering in Kansas and Missouri.

Jack McIntyre, of Bloomfield, Ind., has been appointed county highway superintendent for Greene County, Ind., to succeed Herbert Hudson, who was recently called for active duty in the Army.

William MacBride, formerly an engineer for Servel, Inc., has joined the York, Pa., office of the contract distribution branch of the War Production Board, as an engineer.

Henry C. Hengels, Milwaukee architect and Wisconsin state military architect, has been appointed deputy quartermaster general in charge of construction of the observation squadron hangar at Gen. Mitchell Field, Milwaukee, and on the construction program at Camp Williams, Wis.

Among engineers recently called to duty with the United States armed forces are: Navy, **Lt. Com. Walter A. Ru-Keyser, Lt. C. C. Broadbent, Lt. Leo. L.**

Now that every possible ton of steel is needed for defense, consider using compressed concrete piles, wherever soil is firm enough to serve as a form.

From a 16-inch compressed pile to carry 30 tons, driven in 1927 for The M. O'Neil Company of Akron, to a 36-inch caisson pile driven in 1941 to carry 475 tons for the G. L. F. Holding Corporation of Buffalo, we've proved over and over again that this type of foundation, when intelligently used, gives results that stand up to every test.

If the compressed concrete pile suits your soil, we can promise you a fast, safe, economical job — and one that saves steel for defense.

WESTERN FOUNDATION COMPANY
WESTERN CONCRETE PILE CORPORATION

New York Office
52 Vanderbilt Ave.

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for Better Roads and Streets

Reilly COAL TAR PRODUCTS

● BITUVIA road tar construction offers distinct advantages to both contractor and public. BITUVIA is easily applied, and its deep penetration holds the aggregate firmly for long service, assuring construction and maintenance economies. The highly resilient and skid-resistant BITUVIA surface contributes substantially to traffic safety. BITUVIA is made in seven types to meet any Federal, State, County or Municipal specification.

PLASTUVIA CRACK FILLER

Years of service have proved the unusual ability of this plasticised filler to withstand a wide range of temperature and the hardest traffic, without "pull" in summer or chipping in winter. PLASTUVIA is easily applied, and holds tenaciously to concrete and brick surfaces.

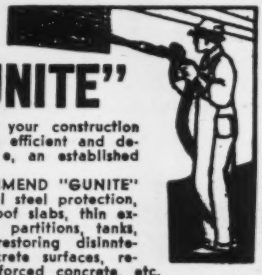
Complete information on these products will be sent on request.

REILLY TAR & CHEMICAL CORPORATION

Executive Offices: Merchants Bank Building, Indianapolis, Indiana

2513 S. DAMEN AVENUE, CHICAGO, ILLINOIS — 500 FIFTH AVENUE, NEW YORK, N. Y. — ST. LOUIS PARK, MINNEAPOLIS, MINN.

SEVENTEEN · PLANTS · TO · SERVE · YOU



"GUNITE"

can reduce your construction costs. It is efficient and dependable, an established product.
WE RECOMMEND "GUNITE" for structural steel protection, floor and roof slabs, thin exterior walls, partitions, tanks, reservoirs, restoring disintegrated concrete surfaces, repairing reinforced concrete, etc. Let us suggest how "Gunite" can best solve your problems.

PRESSURE CONCRETE CO.
"GUNITE" CONTRACTORS
6 Avenue B — Newark, N. J.

WILLIAMS *Buckets*

WELDED ROLLED STEEL CONSTRUCTION

All types and capacities for all conditions. Send for Catalog.

THE WELLMAN ENGINEERING COMPANY
7000 Central Ave., Cleveland, Ohio

built by **WELLMAN**

Landauer, Lt. C. H. Darby, Lt. Joseph B. Diamond; Army: **Capt. C. W. Hoppe** and **Lt. Lunsford C. Pittman**.

Richard V. Trusdell, jr., has been appointed assistant technician of the Buffalo City Planning Association. **Charles Diebold, Jr.,** association president, said Mr. Trusdell will concentrate on phases of the organization's redevelopment program.

John W. Barriger, chief examiner until last July in the railroad division of the Reconstruction Finance Corporation, has been named associate director of the division of railway transport, Office of Defense Transportation.

Marshall N. Oliver of the Corps of Engineers, Denison, Texas, district office, has been assigned as resident engineer to direct enlargement and improvement of the Tyler, Texas, municipal airport. He will be assisted by **Hassel L. Holder,** inspector, and **Joe White,** office engineer.

John F. Barbee, formerly a construction company traffic engineer, has been appointed sanitary inspector for the city of Charlotte, N. C.

George Schilling, a graduate of the University of Nevada College of Engineering, has been appointed city engineer for Sparks, Nev. He succeeds Calvin Dodson, who has been called to active service in the Army.

Allison B. Curry, formerly city manager at Coral Gables, Fla., has been appointed city manager of Miami, Fla.

Charles A. Pfeiffer of Gloversville, N. Y., has been appointed city engineer of Fulton, N. Y.

Frank P. Graham has been appointed county engineer of Mercer County, Pa., with headquarters in Grove City.

G. Medwin Peek, of DeLand, Fla., has become a civilian associate engineer in the architectural department of the Corps of Engineers at Jacksonville, Fla.

George A. Reese of Canton, Ohio, consulting engineer, has been retained as city engineer at Kent, Ohio.

W. G. Bestor has been appointed county engineer for Union County, Ia., with headquarters at Creston. He was formerly county engineer for Clarke County.

Charles E. Firestone, of Canton, Ohio, head of the firm of Firestone & Motter, architects, has been appointed a member of the State Board of Examiners of Architects.

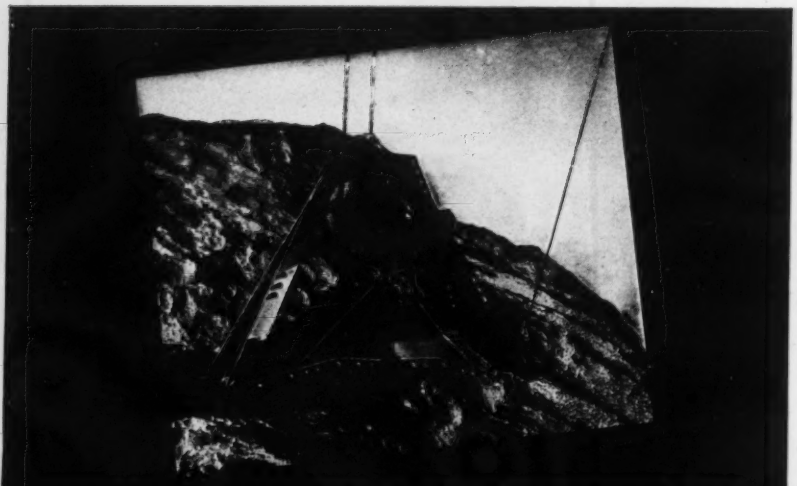
HOIST THE LOAD, RAISE THE BOOM, WHILE SWINGING

Independent boom control saves seconds on material handling work. Independent boom control permits accurate spotting of forms and buckets. Hoisting while swinging or traveling saves more seconds. Raising or lowering the boom while swinging or traveling is a second-saver. With Koehring Cranes on the job waste motion is reduced to a minimum. Every move is a productive move . . . be it traveling, hoisting, loading or unloading, spotting buckets, steel or forms. The many time-saving advantages of Koehring means speed on the job . . . more production per hour.

KOEHRING COMPANY • Milwaukee, Wisconsin

KOEHRING K HEAVY DUTY

HEAVY-DUTY CONSTRUCTION EQUIPMENT



YOU CAN BANK ON A BROWNHOIST BUCKET

Industrial Brownhoist buckets represent the last word in good design and construction. Light weight is combined with unusual strength. Rope wear is reduced to a minimum. Because of the clean, deep bites they take, hand shoveling is practically eliminated. Standard buckets on hand ready for immediate delivery. Write for further facts.

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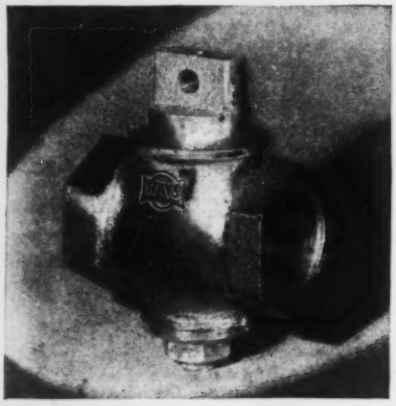
BAY CITY, MICHIGAN • DISTRICT OFFICES: NEW YORK, PHILADELPHIA, CLEVELAND, CHICAGO



COMPRESSED AIR, GAS AND STEAM STOPS FOR INDUSTRIAL LINES

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HAYS MANUFACTURING CO., ERIE, PA.

COPPER • LEAD
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HAYS WATER WORKS PRODUCTS

Since 1869

Compact! Powerful! Safe!

DISTRIBUTABLE CONTROLLED POWER

with Beebe Bros. ALL STEEL HAND HOIST

SEATTLE, U.S.A.

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Money Has Been Saved on These Jobs!

1200' assembled pipe (132 Tons) were lowered to bed of Mississippi at St. Paul with 9—5-Ton Beebes, three lines to each hoist through blocks.

Hudson River Bridge sidewalks were laid in sections with 32—5-Ton Beebes.

Longest wooden trusses in world were installed with ONE 5-Ton Beebe after power hoists proved impractical.

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When raising, lowering, or placing costs by power are a serious problem, the answer is the right number of Beebe Bros. All Steel Hand Hoists MANNED IN UNISON. Available in 2, 5 and 15 Ton sizes. Sold through leading dealers in all trade centers. List of dealers sent upon request.

BEEBE BROS., 2720 6th Ave. S., Seattle, U.S.A.

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"THE STRONGEST GEARED POWER FOR ITS WEIGHT IN THE WORLD"

MEETINGS

AMERICAN ROAD BUILDERS ASSOCIATION, Peabody Hotel, Memphis, Tenn., March 2–6.

AMERICAN SOCIETY FOR TESTING MATERIALS, Committee meetings, Hotel Cleveland, Cleveland, Ohio, March 2–6.

13th ANNUAL SAFETY CONVENTION AND EXPOSITION, Hotel Pennsylvania, New York, N. Y., March 3–6.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Palmer House, Chicago, March 17–19.

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS, annual meeting, Ambassador Hotel, Atlantic City, N. J., April 16–18.

AMERICAN SOCIETY OF CIVIL ENGINEERS, Spring meeting, Hotel Roanoke, Roanoke, Va., April 22–23.

REGIONAL AND LOCAL MEETINGS

NEW JERSEY SEWAGE WORKS ASSOCIATION, 27th annual meeting, Stacy-Trent Hotel, Trenton, N. J., March 5–6.

NEW YORK STATE SOCIETY OF PROFESSIONAL ENGINEERS, mid-winter meeting, Ten Eyck Hotel, Albany, N. Y., March 6–7.

N. J. MOSQUITO EXTERMINATION ASSOCIATION, 29th annual meeting, Atlantic City, N. J., March 11–13.

PENNSYLVANIA WATER WORKS OPERATORS' ASSOCIATION, Eastern Penna. Section, Reading, Pa., Feb. 27; Western Penna. Section, Wilkinsburg, Pa., March 11.

TEXAS SECTION, AMERICAN SOCIETY OF CIVIL ENGINEERS, spring meeting, Austin, Tex., March 13–14.

Elections and Activities

MORE THAN 900 Minnesota engineers met at Minneapolis Feb. 12–14 in a joint session of the Minnesota Federation of Architectural and Engineering Societies with the Minnesota Association of Professional Engineers and the Minnesota Surveyors and Engineers Society. Federation officers elected included J. C. Robbers, St. Paul, president; J. Gordon MacDonald, Duluth, first vice president; H. M. Pickering, Hibbing, and J. H. Kuhlman, Minneapolis, vice presidents; W. S. Cockroft, St. Paul, treasurer. Association officers elected were A. C. Leonard, Rochester, president; P. V. Burgett, Eveleth, vice president; A. S. Milinowski, St. Paul, secretary; E. S. Rankin, Brainerd, secre-

tary-treasurer. Surveyors and Engineers Society officers were Nels Johnson, St. Paul, president; M. L. Jones, St. Paul, vice president, and H. G. Nicholson, Minneapolis, secretary-treasurer.

J. S. KENNEDY, of Akron, was elected president of the Ohio Society of Professional Engineers at the final business session of the group's sixty-third annual convention at Columbus February 13. Other officers elected included Walter Graf of Lancaster, first vice president; Noah H. Truax, of Sidney, second vice president, and Robert Tucker, of Columbus, treasurer.

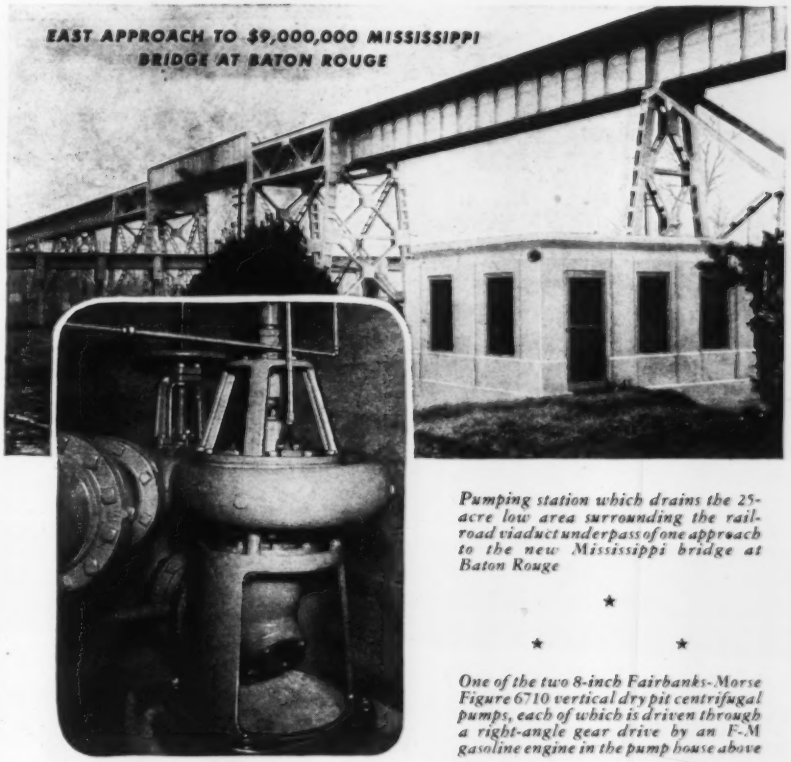
H. DUKE PETERS, of Jacksonville, first vice president of the Northeast Florida Association of Registered Professional Engineers and Land Surveyors, was elected president of that organization at an annual meeting held Feb. 11 in Jacksonville. Other officers elected were E. W. Curtis, first vice president; Nat Green, second vice president; Arthur N. Solee, secretary, and Clarence H. Moore, treasurer. All new officers are of Jacksonville.

IOWA engineers concluded their fifty-fourth annual meeting at Cedar Rapids Feb. 13, after electing Maurice Miller, of the Hawkeye Portland Cement Co., of Des Moines, president; E. W. Blom, city engineer of Ames, vice president; A. F. Fault, highway commission testing laboratory of Des Moines, treasurer. W. L. Anderson, of Primghar, was retained as chairman of the highway section; John Hiland, of Ames, is chairman of the structural and architectural section.

TWO HUNDRED highway engineers from ten southern states attended the meeting at Asheville, N. C. Feb. 12–13, of the Southeastern Association of Highway Officials. W. Vance Baise, chief engineer of the North Carolina Highway and Public Works Commission, of Raleigh, was re-elected president; Chris J. Sherlock, Montgomery, Ala., was re-elected vice president, and Berrien W. Davis, of Raleigh, N. C., secretary-treasurer.

J. B. CARLOCK, chief engineer of plants, Jones & Laughlin Steel Corp., was elected president of the Engineers' Society of Western Pennsylvania at a recent meeting in Pittsburgh. Other officers elected included E. A. Holbrook, dean of engineering, University of Pittsburgh, senior vice president; J. K. B. Hare, central district manager for Westinghouse Electric & Mfg. Co., junior vice president; K. F. Treschow, re-elected secretary; A. Stucki, president of the Stucki Co., treasurer.

THE WISCONSIN CONCRETE PRODUCTS ASSOCIATION, inactive in recent years, has been revived with Edward Olsen, Oshkosh, Wis., as president.



Pumping station which drains the 25-acre low area surrounding the railroad viaduct underpass of one approach to the new Mississippi bridge at Baton Rouge

★ ★ ★

One of the two 8-inch Fairbanks-Morse Figure 6710 vertical dry pit centrifugal pumps, each of which is driven through a right-angle gear drive by an F-M gasoline engine in the pump house above

FAIRBANKS-MORSE PUMPS
Drain Bridge Approach

● The east approach to the new Mississippi River bridge north of Baton Rouge, La., underpasses a railroad viaduct on land that's lower than the river's high-water level. Therefore, during periods of high water or excessive rainfall, a 25-acre tract must be drained by pumping.

Selected for this important job were two 8-inch Fairbanks-Morse Fig. 6710 vertical dry pit centrifugal pumps, each with a capacity of 2200 g.p.m. Each pump is driven by a 6-cylinder F-M gasoline engine. The engines are started and stopped automatically by float switches in a near-by sump.

Dependable, economical, and efficient, these F-M pumping units meet the rigid standards of the bridge engineers. And whether *your* pumping problems are concerned with handling flood waters or sewage, or with water supply, you, too, will find exactly the right pumps in the complete and highly engineered F-M line.

Fairbanks-Morse pump engineers are always available for consultation and collaboration on any pumping problem, without cost or obligation. Write Fairbanks, Morse & Co., Dept. B29, 600 S. Michigan Ave., Chicago. Branches and service stations throughout the United States and Canada.

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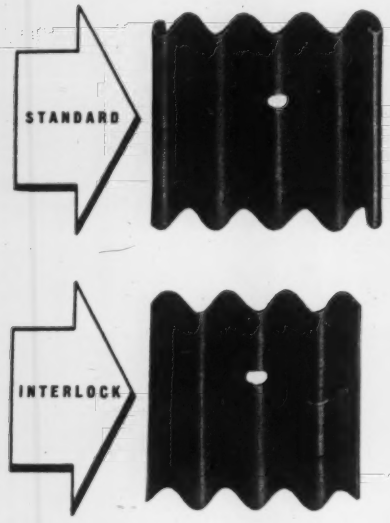
DIESEL ENGINES · ELECTRICAL MACHINERY · MAGNETOS · RAILROAD EQUIPMENT · WASHERS · IRONERS · STOKERS · PUMPS · MOTORS · FAIRBANKS SCALES · WATER SYSTEMS · FARM EQUIPMENT · AIR CONDITIONERS

2 TYPES OF CORRUGATED TO MEET YOUR NEEDS



Not only is Corrugated designed especially to give strength with light weight, it is also made in two types to fit the requirements of almost every piling job.

This plus the fact that Corrugated is easy to transport, stack and install; that it saves man hours and power, can be reused time and time again, are all reasons why it is being specified on Federal, State and Municipal jobs throughout the country. Why not consider Corrugated on the next job you figure? Send for specification book today.

CAINE STEEL CO.

1820 North Central Ave., Chicago

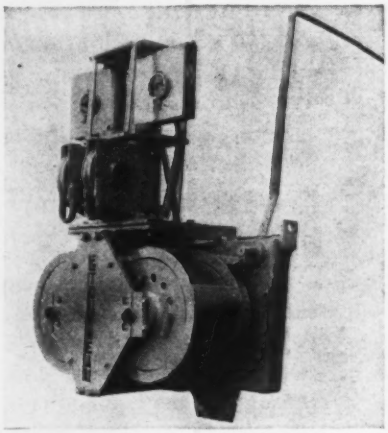
CORRUGATED STEEL SHEET PILING

New Aids to the Constructor

Equipment and material announcements and manufacturers' news

High Discharge Truck Mixers

A complete line of Rex "Hi-Discharge" Moto-Mixers and Moto-Agitators are new in design and have many revolutionary features. Primary among these are rear charging, an improved mixing principle, and a high discharging point for greater spouting range. The Rex mixing principle makes the drum self-cleaning, while mixing. Unlike any other high discharge truck mixer, the Rex drum has one opening for both charging and discharging and uses that entire opening for both purposes—with no charging door to put on or off. There is a big wide rear charging hopper which has a triple function, serving as a receiving hopper for aggregate while charging, a stationary throwback blade while mixing, and at the same time affords visibility or permits sampling of the batch. The "Hi-Discharge" can place concrete over 20 to 22 foot areas on all types of jobs.—*Chain Belt Co., Milwaukee, Wis.*

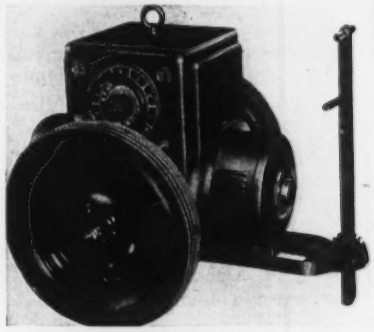


Control Unit for Larger Tractors

LeTourneau has introduced the R6-7-8-power control unit designed for use on a D6, D7 or D8 Caterpillar tractor.—*R. G. LeTourneau, Inc., Peoria, Ill.*

Strain Gage

A new Whittemore strain gage is available and can be used either in the field or in the laboratory by observers having very little training. The frame of the improved Whittemore strain gage consists of two co-axial tubes connected near the ends by fulcrum plates of thin spring steel which effectively constrain the tubes to move axially. A point is rigidly attached to one end of each tube. When the points are seated in small holes in the specimen the position of one tube with respect to the other is indicated on the dial micrometer clamped in the inner tube. A handle partially incloses the tubes.—*The Baldwin-Southwark Div. of the Baldwin Locomotive Works, Philadelphia.*



Trailer for Welder Mounting

A new two-wheeled, light-weight, pneumatic-tired trailer for mounting 200, 300, 400 ampere Hobart electric drive welders is designed for road towing up to 35 m.p.h. The trailer is so designed that mounting the welder is accomplished easily by means of three bolts in the frame of the trailer which register with three holes in the legs of the welding machine. The unit is easily moved by hand but is capable of trailing over very rough terrain.—*Hobart Brothers Co., Troy, Ohio.*

Reproducing Tracings

Confidential expert advice is offered to government contractors and sub-contractors on a time-saving method of reproducing drawings required under government contracts, which require duplicate copies of drawings and tracings of particular equipment. Through a special process, Post is prepared to supply the originals required to meet government specifications. With your request for information, specifically state whether the contracts are for Army, Navy, Air

Only JAEGER Pumps Have All These Features

- **JAEGER PRIMING JET** — Up to 5 times faster prime and re-prime — no adjustments, no need to "gun" engine.
- **POSITIVE RECIRCULATION CUT-OFF** — controlled by flow, not pressure.
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- **PATENTED SELF-CLEANING SHELL.**
- **EVERY PUMP FACTORY TESTED** for high capacity and pressure.
- **COMPLETE RANGE OF SIZES, TYPES** — 3,000 to 220,000 g.p.h.

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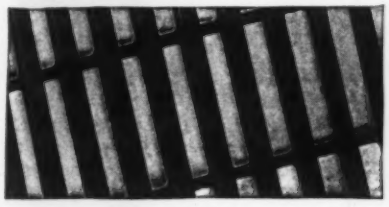
When you need grates
Specify **BATES**
FOR LONG-TIME ECONOMY



FILLET WELD

BATESGRATES

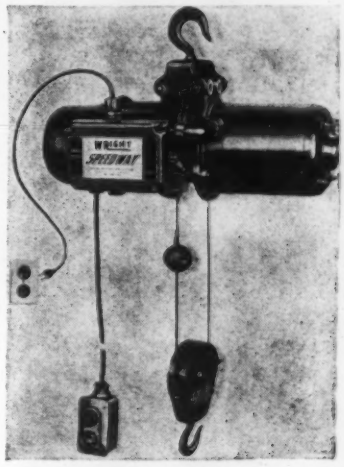
—One Piece Construction
OPEN STEEL FLOOR GRATING

Each intersection, and consequently, each complete panel of Batesgrates, is strictly one piece. Non-slip, sharp top edge, self cleaning cross bars like the ridge of a roof. No cracks, joints, or acute angles. No grooves to hold grease and dirt and create slippery spots. Batesgrates are an engineered assembly of bars — all bars work.

Write for engineering Catalog No. 937.

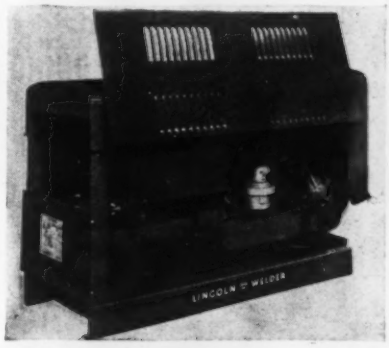
WALTER BATES COMPANY
208 S. LaSalle St. Chicago, Ill.

Corps or other governmental departments. Requests for such information must be made on business letterhead and signed by an officer of the company.—*Frederick Post Co., Box 803, Chicago, Ill.*



Electric Hoist

Shown above is the Speedway, a new light weight compact wire rope electric hoist available in capacities from 250 to 1000 lb. Portability, flexibility and accessibility are outstanding features of this hoist, which has push button control and safety limit switches and is weather-proof, acid-proof, and dust-proof. It is available for 110 or 200 volt single phase 60 cycle current and for 220 or 440 volt three phase 60 cycle.—*Wright Mfg. Division of the American Chain & Cable Co., Inc., York, Pa.*



200-Ampere Welder

A new engine driven arc welder is especially designed for job welding and construction garage work which embodies a new system of engine-speed control for maximum fuel economy and minimum engine wear. Of 200-ampere size, this new unit is engineered for profitable welding applications of all sizes and types. It has a current range of 40 to 250 amperes, is compact and light in weight, and of the direct current type. The welder is powered by a Her-

"St. Paul's Cathedral, London."

A Concrete Proposal

Concerning floors, British floors, that give you a better margin of profit and a quicker turnover. Bison Pneumatic Core Floors are in ever-increasing demand in Great Britain as the quickest and best floor on the market to-day.

Bison Floors need no timber shuttering and, being precast, avoid wet concrete and cut out the wait for hardening. They combine great strength with lightness, and the pneumatic core process used in forming the cavity is so simple and cheap that mass production of Bison floor units proves very profitable.

This system is now offered to you by Concrete Limited, of Leeds and London, the originators of this British floor—who are appointing licensees to operate the process on a royalty basis.

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. . . If you want to make speed profitably . . . GET DEPENDABLE EQUIPMENT . . Buy the Fast . . .

JACKSON Hydraulic Concrete Vibrator

DESIGNED TO "TAKE IT" 3 SHIFTS A DAY EVERY DAY

- Automatic pressure lubrication—requires no attention.
- 34-ft. hose—2¾" vibrator head.
- Adjustable frequency to 6800 R.P.M.—submerged in concrete.
- Powerful gas engine—4.7 H.P.
- Long-lived, ball-bearing, rotary, hydraulic pump.

USED EXCLUSIVELY BY MANY LARGE DEFENSE CONTRACTORS

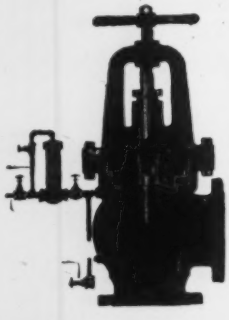
ELECTRIC TAMPER & EQUIPMENT CO.

LUDINGTON, MICHIGAN

Triple-Acting Non-Return Valve

This valve will automatically cut in a boiler whenever its pressure equals line-header pressure; it will isolate a boiler automatically whenever its pressure, from any cause, is lower than line-header pressure; and it will prevent steam flow from the boiler in event of sudden drop of line-header pressure below the boiler pressure, by means of differential shot pilot valve functioning.

Write for specifications.



Furnished in angle, globe and elbow patterns, sizes 2½" to 12"; also available in larger sizes, as well as in the Cross pattern.

GOLDEN-ANDERSON VALVE SPECIALTY CO.
Fulton Building Pittsburgh, Pa.

- **BUILDING MOVING**
- **ENTIRE TOWNS MOVED**
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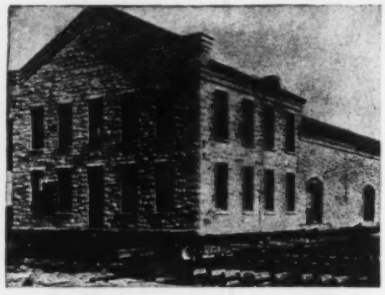
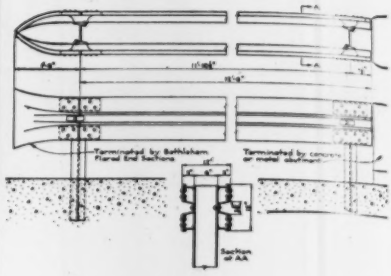


Bloomington, Ill. — Stone freight house, size 40 feet by 225 feet moved sidewise 160 feet, turned one-eight, then moved endwise 275 feet, for Chicago and Alton R. R.

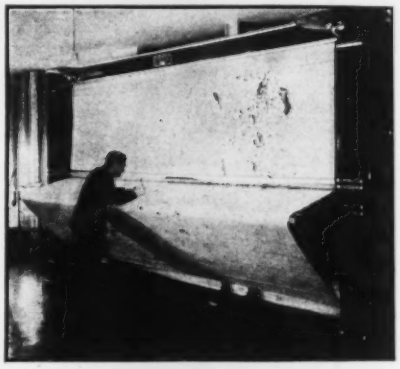
E. W. LA PLANTE CO.
2325 EAST 46TH STREET
INDIANAPOLIS, INDIANA

cules industrial engine equipped with centrifugal type governor, high tension magneto with impulse starter coupling, and oil bath air cleaner.—*The Lincoln Electric Co., 12818 Coit Road, Cleveland, Ohio.*



Traffic Divider

A new traffic divider consists of a heavy cold rolled section made of strip steel, 18 in. wide before rolling, 12 in. wide after and is available in standard 12 ft. 6 in. lengths (or longer, if desired). The wide channel construction offers both high strength and positive visibility. It is easy to install, with any type of post, although steel posts are preferred.—*Bethlehem Steel Co., Bethlehem, Pa.*



Maps on a Large Scale

Designed to facilitate the handling of large maps, the new roll map case shown above houses and displays maps 8, 10, or 12 ft. size in continuous rolls up to 250 ft. in length. Maps are attached to each other by zippers. The maps are housed in a storage compartment which is insulated for fire protection. The front of the storage compartment is so designed that it can be raised to drafting board position with a working surface length equal to the length of the map by 24 in. wide. This surface is covered with cork linoleum and can be raised to any desired height for standing or sitting position of the operator. The cases are custom-built and are designed for manual or electrical operation.—*Motors Metal Mfg. Co., Milford Ave., Detroit, Mich.*

Manufacturers' Activities

THE HARNISCHFEGER CORP. of Milwaukee has appointed R. D. HOLCOMB as district manager in charge of the San Francisco office.

THE MARMON-HERRINGTON CO., INC., of Indianapolis, Ind., has appointed WILLIAM H. KLETT to the export staff of the company to take charge of Latin American business.

HENRY B. MANTON, president of the ROBINSON CLAY PRODUCT CO., Akron, Ohio, died recently. Mr. Matnon, a graduate of Cornell University, was the son of one of the founders of the company and was active in Akron business and civic affairs.

THE MINNEAPOLIS-HONEYWELL REGULATOR CO. is now constructing an addition to its plant at Minneapolis, Minn., to add 65,000 sq.ft. of floor space to accommodate recent defense orders.

G. COOK KIMBALL, former Chicago executive vice president of the UNITED STATES STEEL CORP. of Delaware, died at his Chicago home recently.

RALPH SPURRIER, formerly general manager of the ROAD SUPPLY & METAL CO. of Topeka, Kan., has become associated with the MIDWEST DRAINAGE PRODUCTS CO., also of Topeka. The new corporation manufactures corrugated iron and concrete culverts and sewer pipe for all drainage purposes.

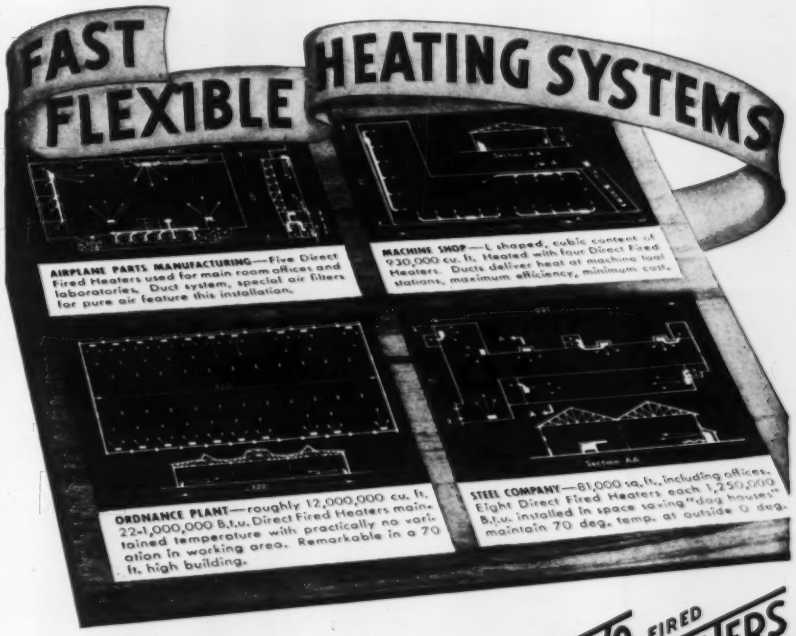
The WELLMAN ENGINEERING CO. has changed the location of its Chicago office to Room 1112, Merchandise Mart, 222 West, North Bank Drive. JOHN E. CARLSON of the WILLIAMS BUCKET division of Wellman is in charge of the WILLIAMS CLAMSHELL and DRAGLINE BUCKET sales and service at this branch office.

A. G. MULKEY, formerly manager of the Seattle branch for the WAUKESHA MOTOR CO., Waukesha, Wis., has been appointed Pacific coast manager for the company.

THOMAS JOHN CONNOR, 48 years old, vice president in charge of production and a member of the board of directors of the CATERPILLAR TRACTOR CO., Peoria, Ill., died recently. He became general factory manager of Caterpillar Tractor Co. in 1930 and a director in 1934.

The FREDERICK POST CO. announces the opening of a new factory branch at 1215 Capitol St., Houston, Texas.

ARTHUR T. COX, jr., has been elected vice president of the LINCOLN ELECTRIC RAILWAY SALES CO., making his headquarters at Chicago, Ill.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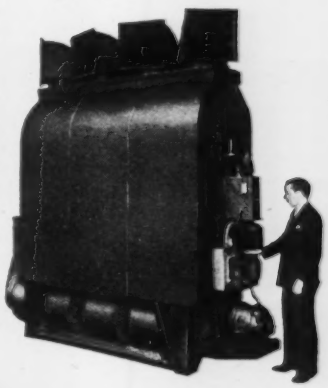

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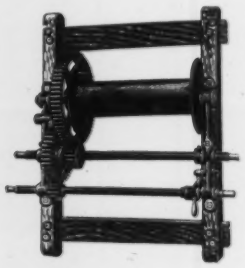

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